AN INVESTIGATION INTO MOMENTUM ANOMALY:

EVIDENCE FROM THE NAIROBI SECURITIES EXCHANGE

By

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DECLARATION

I hereby declare that this MBA Research Project is my original work which has not been submitted for a degree at the University of Nairobi or any other University.

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DEDICATION

To my dear wife Nancy, and our kids Darren and Caren

ABSTRACT

This study set out to investigate further evidence on momentum anomaly at the NSE. Part of the study involved decomposing momentum profits based on firm size and testing for the influence of FF three-factor model.

At the beginning of each month t the stocks are ranked in ascending order based on their cumulated returns over the previous J months where J is 3, 6, 9 or 12. Based on the rankings, the stocks are assigned to one of three terciles. The portfolios are then held for the next K months, where K is 3, 6, 9 or 12. t-statistics are then used to test the hypothesis.

The six month formation strategy outperforms all other strategies irrespective of the holding period. All the zero cost strategies yield positive returns which are statistically significant except the 12-month/12-month strategy. The best performing strategy is the 6-month/3-month which gives an average monthly return of 1.62 %.

The 6-month/6-month strategy is used to decompose momentum profits based on firm size. The smallest firms generate the lowest abnormal returns, while the largest firms generate lower abnormal returns compared to medium firms. Time series regressions show that the FF three-factor model does not influence momentum profits.

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ABBREVIATIONS

BE – Book Equity

CAPM – Capital Asset Pricing Model

CRSP – The Center for Research in Security Prices

E/P – Earnings Price Ratio

EMH – Efficient Market Hypothesis

FF – Fama and French

HML – High minus Low

ME – Market Equity

NSE – Nairobi Securities Exchange

NYSE – New York Stock Exchange

SMB – Small minus Big

CHAPTER ONE

INTRODUCTION

1.0 Background

An anomaly is a pattern in average stock returns that cannot be explained by the Capital Asset Pricing Model (CAPM). Studies have shown that such anomalies include size, value, profitability, growth, accruals, net stock issues, and momentum (Fama & French, 2008). The anomaly debate followed the discovery of significant flaws with the CAPM, which has dominated finance theory for over thirty years.

Momentum anomaly can be defined as the medium-term continuation of equity returns (Lishenga *et al.*, 2011). That is, past winners continue to perform well and past losers continue to perform poorly at medium-term horizons of 3 to 12 months (Jegadeesh & Titman, 1993). I advance the momentum anomaly debate, by documenting further evidence for momentum anomaly at the NSE. Momentum strategy is also known as relative strength strategy.

CAPM was developed by Sharpe (1964) and Lintner (1965) building on the earlier work of Harry Markowitz on diversification and modern portfolio theory. Further empirical evidence is supported by many authors, most notably Black (1972). CAPM asserts that the correct measure of risk is the market beta, with a linear relationship between the expected risk on individual assets and their systematic and beta risk (Lam, 2005). In other words, expected returns vary across the market only because of the assets' market betas. Put differently, the market beta alone is sufficient to explain security returns (Drew & Veeraraghavan, 2003).

CAPM has been theoretically underpinned by mean-variance portfolio efficiency, which postulates that the market beta suffices to explain expected return (Hung, 2006). The model makes various assumptions, most notable being that all investors aim to maximize economic utility. Other assumptions include: all investors are rational and risk-averse; they are price takers, that is, they cannot influence prices; they can lend and borrow unlimited under the risk free rate of interest; they can trade without transaction or taxation costs; they deal with securities that are all highly divisible into small parcels; it is assumed that all information is at the same time available to all investors; and finally the model assumes that markets are perfectly competitive.

Although the single beta CAPM managed to withstand more than three decades of intense scrutiny, for some time the consensus is that a single factor model is not sufficient to describe the cross section of expected stock returns (Drew & Veeraraghavan, 2003).

Several studies have shown that anomalies are pervasive in stock markets, for example Black (1972), Banz (1981), Basu (1983) and Roll (1988). The 80's marked the era when these imperfections were uncovered (Lishenga *et al.*, 2011). These deviations are considered challenges to the validity of CAPM.

Using their own work based on cross sectional approach and earlier findings from other researchers. Fama and French (1992) confirm that size, earning price ratio, debt-equity and book to market equity ratio have an explanatory power to stock average returns. They also observe that stocks with high book to market equity ratios have high average returns that are not captured in beta. This shows some other characteristic other than beta have explanatory power on expected returns and these led to the challenges on CAPM.

The pioneering work on momentum anomaly studies was advanced by Jegadeesh & Titman (1993). Locally at the NSE, three major studies on momentum have been carried out by Omuronji (2005), Muriuki (2006) and Lishenga *et al.*, (2011). Despite slight variations in their results, they all concur that there is evidence of momentum anomaly at the NSE.

More recently, Fama and French (2008) studied the effect on average stock returns of seven anomalies of size, value, profitability, growth, accruals, net stock issues, and momentum. Despite combining all anomalies in the same study, the premier anomaly is still momentum, which adds further evidence to existence of momentum anomaly in stock markets around the world.

1.1 Context of the Study

The study is carried out at the NSE, which was constituted as a voluntary association of stock brokers registered under the societies Act in 1954. In 1991 the NSE was incorporated under the companies Act of Kenya as a company limited by guarantee and without a share capital. Subsequent development of the market has seen an increase in the number of stockbrokers, introduction of investment banks, establishment of custodial institutions and credit rating agencies and the number of listed companies have increased over time. Securities traded include, equities, bonds and preference shares (Ngugi, 2005).

During the study period (January 2000 – December 2007), the NSE had approximately 50 active listed companies of which 20 % were listed on the Alternative Investment Market Segment, 36 % on the industrial and allied sector and 14 % on the agricultural sector.

1.2 Statement of the Problem

The pioneering work of Jegadeesh and Titman (1993) on momentum anomaly studies following widespread evidence of anomalies in stock markets around the world is well documented. Further research studies have shown that momentum anomaly is pervasive in most stock markets around the world (e.g. Benson *et al.*, 2007).

Momentum studies seek to determine if past performance is a predictor of future performance and if economically profitable trading strategies can be executed using historical information (Benson *et al.*, 2007). Recent studies seek to establish the causes of momentum profits (e.g Hong *et al.*, 2000).

Previous momentum studies at the NSE have not considered effects such as the negative correlation (reversal rather than continuation) of month-to-month returns as documented by Fama and French (2008). In addition, the NSE is characterized by much fewer counters, necessitating a review of the methodology employed. Last but not least, only one study at the NSE has tried to establish the causes of momentum profits, but did not investigate the influence of firm size on momentum profits in detail. This is the study carried out by Lishenga *et al.*, (2011).

The study specifically attempts to answer the following research questions: -

a) is momentum anomaly pervasive at the NSE?
b) does firm size influence momentum profits at the NSE?
c) is there a relationship between the Fama and French risk factors and momentum profits?

1.3 Objectives of the Study

The objective of this study is to quantify and establish further evidence of momentum anomaly at the NSE, and to establish the relationship between the Fama and French risk factors and momentum profits.

1.4 Importance of the Study

Information on prevalence of anomalies is useful for both policy makers and investors. Specific information on momentum anomaly is useful to investors who would know what action to take at what time. The specific benefits and importance of this study are outlined below.

a) the academic dimension to contribute to the body of knowledge on anomalies in stock markets,

b) to educate the public on understanding what factors to consider when investing in the stock markets, thus useful in their evaluation and valuation of securities,

c) as an aid to policy making organs of the Government, helping them gain insight into various issues such affecting the stock market, hence accommodate them in the policies,

d) to financial consultants to provide accurate information to various stakeholders who make investment decisions, and last

e) companies issuing securities and advisory services can be aided in making sound financial decisions.

The rest of this study advances as follows. Chapter 2 reviews the literature related to momentum anomaly. Chapter 3 reviews the methodology employed in the study. Chapter 4 presents discussions and recommendations of the study. Finally, Chapter 5 gives the conclusions, summary and recommendations. This chapter also outlines the problems encountered in the study as well as areas for further study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In this section I synthesize the literature related to anomalies in general, and momentum anomaly in particular. To cover the literature adequately, I include the seminal studies of CAPM and Efficient Market Hypothesis (EMH).

2.1 The CAPM and EMH

Sharpe (1964), in his seminal paper "*Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk*", made one of the first attempts to construct a market equilibrium theory with implications consistent with the assertions of traditional financial theory at the time, based on the earlier works of Harry Markowitz and others. He concluded that there is a positive simple relation between average stock returns and their market beta, a proxy for systematic risk.

According to Lintner (1965), the investor's net expected rate of return on his total net investment is related linearly to the risk of return on his total net investment as measured by the standard deviation of his return. This observation is in line with Sharpe (1964). This means that the market portfolio of invested wealth is mean variance efficient, which implies that market beta is enough to describe the expected returns.

Black (1972) summarized the assumptions underlying the asset pricing models advanced by Sharpe (1964) and Lintner (1965) as a) all investors have the same opinions about the possibilities of various end-of-period values for all assets, i.e. they have a common joint probability distribution for all the returns on the available assets, b) the common probability distribution describing the possible returns on the available assets is joint normal (or joint stable with a single characteristic exponent) c) investors choose portfolios that maximize their expected end of period utility of wealth and all investors are risk averse (every investor's utility function on end of period wealth increases at a decreasing rate as his wealth increases), and d) an investor may take a long or short position of any size in any asset, including the risk-less asset.

Algebraically, the CAPM is written as:

$$E(R_i) = R_f + \beta_i (E(R_m) - R_f)$$

Equation 1: Capital Asset Pricing Model

Where $E(R_i)$ is the expected excess return on the capital asset; R_f is the risk-free rate of interest such as interest arising from government bonds; β_i is the sensitivity of the expected excess asset returns to the expected market returns, and $E(R_m)$ is the difference between the expected market rate of return and the risk-free rate of return

A securities market is said to be efficient if the prices fully reflect all available market information (Obere, 2009). Thus, prices move only when information is received or changes. This rests on very strong assumptions and gives the impression that the cost of acquiring market information is zero. The concept of EMH appeared in 1960s and reached such a height of dominance around 1970s that any deviation in financial markets has been called anomaly (Lishenga *et al.*, 2011).

2.2 Limitations of CAPM and EMH

Being a pioneer model for over thirty years, CAPM has been extensively studied. Over its existence, several limitations of the model have been uncovered. Some of these limitations, which have given impetus to anomaly studies, are outlined in the paragraphs that follow.

First and foremost, CAPM assumes that asset returns are normally distributed random variables. It is however frequently observed that returns in equity and other similar markets are not normally distributed. In addition, CAPM assumes that the variance of returns is an adequate measurement of risk. This might be justified under the assumption of normally distributed returns, but for general return distributions other risk measures will likely reflect the investors' preferences more adequately.

Another limitation is that CAPM assumes that all investors have access to the same information and thus agree about the risk and expected return of all assets. This is far from reality. Further to this, the model assumes that the probability beliefs of investors match the true distribution of returns, and that given a certain expected return investors will prefer lower risk to higher risk and conversely given a certain level of risk will prefer higher returns to lower ones. Last, the model assumes that there are no taxes or transaction costs, but in reality we have taxes and transaction costs.

2.3 Earlier Studies on Return Anomalies

Early attempts to disapprove the CAPM has been noted by Black (1972), primarily due to assumption that an investor may take a long or short position of any size in any asset, including the risk-less asset, which seems to be the most restrictive. Black goes on to show that when there is no risk-less asset, and no risk-less borrowing or lending, the expected return on any risky asset is a linear function of its beta. These results are consistent with observation of Lintner (1965) and Sharpe (1964).

Banz (1981) examined the empirical relationship between the return and the total market value of NYSE common stocks. He found out that smaller firms have had higher risk adjusted returns, on average, than larger firms. The size effect is not linear in the market value; the main effect occurs for very small firms while there is little difference in return between average sized and large firms. The empirical tests were based on a generalized asset pricing model which allowed the expected return of a common stock to be a function of risk, beta and an additional factor alpha, the market value of the equity. The conclusion of the study is that the market equity adds to the explanation of the cross-section of average returns provided by the market.

Basu (1983) showed that earnings-price ratio (E/P) help explain the cross-section of average returns on United States stocks in tests that also include size and market factor. The methodology employed involved partitioning securities into groups or classes on the basis of their E/P ratios and the market value of their common stocks. The results confirm that the common stock of high E/P firms earn, on average, higher risk-adjusted returns than the common stock of low E/P firms and that this effect is clearly significant even if experimental control is exercised over differences in firm size. On the other hand, the size effect virtually disappears when returns are controlled for differences in risk and E/P ratios.

DeBondt and Thaler (1985) investigated whether over-reaction as a behavior of investors affects stock prices. Using CRSP monthly return data, their study was based on experimental psychology research which showed that most people tend to over-react to unexpected and dramatic news events. Based on this, they find out that portfolios of past losers outperform prior winners. Thirty-six months after portfolio formation, the losing stocks have earned about 25 % more than the winners. They conclude that over-reaction affects the stock markets.

Roll (1988) attempted an empirical investigation of the paradigm that stock price changes should be explainable by general systematic influences, industry influences and firm specific events. The author finds that with all explanatory factors included, less than 40 % of the monthly return volatility in the typical stock market can be explained. This tends to suggest that there are other factors other than the market beta affecting stock prices.

Fama and French (1992) found that the single factor market model does not seem to help explain the cross-section of average stock returns. The combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns, at least during the sample period of their study which was 1963-1990. They observed that if assets are priced rationally, their results suggest that stock risks are multidimensional. Risk is used as a proxy in various dimensions: size, i.e. ME (number of shares outstanding times price per share), book-to-market equity i.e. BE/ME, the ratio of the book value of common equity to its market value. Two variables provide a simple and powerful characterization of the cross-section of average stock returns for the study.

Jegadeesh and Titman (1993) used various trading strategies in a study that modeled buying past winners and selling past losers. Such strategies, they find out, realize significant abnormal returns over the 1965 – 1985 period on NYSE and AMEX stock exchange data (based on CRSP daily returns file). The study they examine in most detail selected stocks based on their past 6-month returns while holding them for the next 6-months. This strategy realizes higher than usual returns of 12.01 % per year on average.

Kothari et al. (1995), re-examined whether beta factor explains cross section variations in average stock returns over the post-1940 period as well as the longer post 1926 period, and whether book-to-market equity captures cross section of average returns over the period 1947 – 1987. His findings revealed that average returns do indeed reflect substantial compensation for beta risk, provided that betas are measured at the annual interval. This is in contrast to earlier work by Fama and French (1992) which were based on monthly returns. While doubt has been cast on the explanatory power of BE/ME factor, they see evidence of a size effect. Further, they posit that it is likely that the Fama and French (1992) results are influenced by a combination of survivorship bias in the dataset they used. Using an alternate dataset, they find book-to-market equity is at best weakly related to average stock return.

Fama and French (1996) based on their previous work which showed that average returns on common stocks are related to firm characteristics such as size, earnings/price, cash flow/price, book-to-market equity, among others. They found that except for the *continuation of short-term returns* (i.e. momentum); the anomalies largely disappear in a three-factor model. The then modeled three factors that explains the return on a portfolio in excess of the risk-free rate: (a) the excess return on a broad market portfolio (b) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks; and (c) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks.

Rouwenhorst (1998) used data for the period between 1978 - 1995 in an international context and found evidence of medium-term return continuation in all 12 markets in the sample. The sample consisted of monthly total returns in local currency for 2,190 firms from 12 European countries: Austria (60 firms), Belgium (127), Denmark (60), France (427), Germany (228), Italy (223), The Netherlands (101), Norway (71), Spain (111), Sweden (134), Switzerland (154), and the United Kingdom (494). Using the 6-month/6-month strategy, the main finding of the study is that an internationally diversified relative strength portfolio that invests in medium-term Winners and sells past medium-term Losers earns approximately 1 percent per month. This momentum in returns is not limited to a particular market, but is present in all 12 markets in the sample.

Fama and French (1998) find that value stocks (stocks with high book-to-market ratios) have higher returns than growth stocks (stocks with low book-to-market ratios). For the period 1975 – 1995, the difference between the average returns on global portfolios of high and low book-to-market stocks is 7.68 % per year, and value stocks outperform growth stocks in twelve of thirteen major markets. An international CAPM cannot explain the value premium, but a two-factor model that includes a risk factor for relative distress captures the value premium in international returns. In conclusion, value stocks tend to have higher returns than growth stocks in markets around the world. Sorting on book-to-market equity, value stocks outperform growth stocks in twelve of thirteen major markets during the period 1975 – 1995.

(Barberis *et al.*, 1998) presented a model of investor sentiment, that is, how investors form expectations of future earnings. The model was based on psychological evidence of under-reaction of stock prices to news such as earnings announcements, and over-reaction of stock prices to a series of good or bad news. The under-reaction evidence showed that over horizons of perhaps 1 - 12 months, security prices under-react to news. As a consequence, news is incorporated only slowly into prices, which tend to exhibit positive autocorrelations over these horizons. The over-reaction evidence showed that over longer horizons of perhaps 3 - 5 years, security prices overreact to consistent patterns of news pointing in the same direction. That is, securities that have had a long record of good news tend to become overpriced and have low average returns afterwards.

Conrad and Kaul (1998) presented an analysis of momentum and contrarian trading strategies that rely on time-series patterns in security returns for the period 1926 – 1989 using the entire sample of available NYSE/AMEX securities. Their results showed that less than 50 % of the 120 strategies implemented yield statistically significant profits and, unconditionally, momentum and contrarian strategies are equally likely to be successful. They also noted that the momentum strategy usually nets positive and statistically significant profits at medium horizons, while the contrarian strategy is successful at long horizons. They also found that an important determinant of the profitability of trading strategies is the estimated cross-sectional dispersion in the mean returns of individual securities comprising the portfolios used to implement these strategies.

Daniel et al., (1998) using an event study developed a theory based on investor overconfidence and on changes in confidence resulting from biased self-attribution of investment outcomes. The theory implies that investors over-react to private information signals and under-react to public information signals. They show that positive return auto-correlations can be a result of continuing overreaction, which is followed by long-run correction. Thus, short-run positive autocorrelations can be consistent with long-run negative autocorrelations.

Lee & Swaminathan (2000) in their study based on NYSE data showed that that past trading volume provides an important link between "momentum" and "value" strategies. Past trading volume predicts both the magnitude and persistence of price momentum. Specifically, price momentum effects reverse over the next five years, and high (low) volume winners (losers) experience faster reversals. The findings show that past volume helps to reconcile intermediate-horizon "under-reaction" and long horizon "over-reaction" effects.

Drew and Veeraghavan (2003) compared the explanatory power of CAPM and Fama and French (1996) three factor model for Hong Kong, Korea, Malaysia, and the Philippines. They find that CAPM beta alone is not sufficient to describe the cross section of expected returns, implying that there were anomalies such as momentum in the Asia stock markets.

2.4 Recent Studies on Return Anomalies

In this section I review recent studies on anomalies in general and momentum in particular. More focus is placed on empirical and other studies carried out locally at the NSE.

Griffin *et al.,* (2003) examined whether macroeconomic risk can explain momentum profits internationally. The selected countries in Africa included Egypt and South Africa. U.S. monthly stock return data include common shares of all NYSE- and AMEX-listed firms available from CRSP. For non-U.S. data, they selected countries from Datastream International that have at least 50 stocks. Using a 6-month/6-month strategy, they find that the average monthly momentum profit is 1.63%, 0.78%, 0.32%, and 0.77% in Africa, Americas (excluding the United States), Asia, and Europe, respectively. The profits are highly significant in all regions except for Asia.

Oluoch (2004) investigated the small size effect (size anomaly) at the NSE. This anomaly postulates that small capitalization firms generate higher returns than the market average. This study is similar to the study carried out by Banz (1981), who examined the empirical relationship between the return and the total market value of NYSE common stocks. Using a ten year interval, Oluoch (2004) found out that the NSE does not exhibit the size anomaly. He found that smaller firms have had higher risk adjusted returns, on average, than larger firms.

By examining momentum strategy for 3,6,9, and 12 month formation and holding periods for the period 1997 – 2003 at the NSE, Omuronji (2005) finds evidence of momentum at the NSE. The methodology employed comprised selection of 15 highest past performers as the winner portfolio and 15 lowest past performers as the Loser portfolio. The middle portion comprising 30% of firms are excluded. The price on the last trading day of the month was modeled as the ending stock price for the month and also the beginning price for the next month. Her results show that the NSE is not efficient due to the presence of momentum anomaly. Her zero-cost portfolio results for the 3-month/3-month strategy are statistically insignificant; with the best performing strategy being the 12-month/3-month (zero-cost portfolio return of 1.29% per month).

Muriuki (2006) sought to compare the explanatory power of a single factor model with the multifactor model of Fama and French (1996) for companies listed in the main investment market segment at the NSE in the period 1995 – 2005. Using a sample of 41 companies, Muriuki finds out that CAPM beta alone is not sufficient to describe cross section of expected returns. In fact, size and book-to-market help the variation in average stock returns in a reasonable manner. Small and high book-to-market firms generate higher returns than big and low book-to-market equity firms.

A study carried out in Australia by Benson *et al.*, (2007) examined the active asset allocation decisions of Australian multi-sector fund managers to determine whether active fund managers engage in momentum strategies. They found evidence supporting the existence of momentum investing in active asset allocation strategies.

Wainaina (2007), in a study at the NSE set out to establish the existence of momentum using the 52-week high method covering the period 1999 – 2006. Formation strategies were based on 3, 6, 9 and 12 months. Using the 52-week high trading strategy at the end of each of month, all stocks with a return history of 12 months are ranked in ascending order and assigned to one of three portfolios based on their j-month ratios. The ratio was determined by dividing the average holding price at month j with the highest price in the preceding 52 weeks. The results all of zero cost portfolios are positive and range between 0.05 % and 1.13 % with the 3-month/6-month strategy giving the least average monthly return while the 9-month/12-month strategy gives the highest monthly return.

Fama and French (2008) investigated the effect on average stock returns of several anomalies combined together. These anomalies are size, value, profitability, growth, accruals, net stock issues, and momentum. Unlike previous work, the model combined all these anomalies together to see which have information about average returns that is missed by other anomalies. Using regressions and sorts, they find out that the premier anomalies are momentum, net stock issues and accruals, while asset growth and profitability anomalies are less robust.

Lishenga *et al.*, (2011) tested the profitability of momentum strategies at the NSE for the period 1995 to 2007. They employed both relative strength strategies (RSS) and weighted relative strength strategies (WRSS) to implement momentum-based trading strategies. They used RSS results to evaluate the influence on momentum profitability of transaction costs, calendar effects, risk factors and other momentum characteristics, while WRSS results were used to discriminate between the two diametrically opposed causes for the profitability of momentum strategies: behavioral factors (time-series continuation in the firm-specific component of returns), and risk factors (cross-sectional variation in expected returns and systematic risks of individual securities). Similar to Jegadeesh and Titman (1993) and evidence elsewhere, their analysis revealed that the NSE exhibit medium term return continuation.

2.5 Conclusions

As can be seen in the literature, anomaly studies present an interesting area in finance research. There is a possibility to beat the market momentum trading strategies are adopted. This study seeks to add to the existing body of knowledge in this area.

The pioneering work of Jegadeesh and Titman (1993) will be followed. while incorporating advances made since then. Issues specific to the NSE will be taken into account.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This section highlights the techniques used to accomplish the objectives of the study. It reviews the methodology that is employed as well as an account of the research variables and their relationships.

3.1 Research Design

Although the study follows the seminal work of Jegadeesh and Titman (1993) for constructing the representative overlapping momentum strategies, more emphasis is placed on more recent findings such as those of Lee and Swaminathan (2000), Wainaina (2007) and Lishenga *et al.*, (2011).

The study uses data from the NSE for the period January 2000 – December 2007. At the beginning of each month *t* the stocks are ranked in ascending order on the basis of their cumulated compounded returns over a formation period of J months. Based on these rankings, the stocks are assigned to one of three terciles[1]. The portfolios, which are overlapping, are equally weighted and held for the following K months. With the K-

[1] A tercile of portfolios is a group of three portfolios. Compare with decile which is ten portfolios.

month holding period, the composite portfolio position in each month comprises the current month and the past K -1 ranking strategies. In other words, the monthly portfolio return is a combination of 1/K of each of the K strategies.

More precisely, a J-month/K-month trading strategy comprising formation period of J months and holding period of K months is constructed as follows. In any given month t, the strategy holds a series of portfolios selected in the current month as well as in the previous J months. The strategy buys the winner portfolio and sells the loser portfolio holding this position for K months, while closing out the position initiated in month t – K. This is equivalent to revising the weights of approximately 1/K of the portfolio each month and carrying over the rest from the previous month. Similar to the literature on momentum studies, this technique allows the use simple t-statistics for monthly returns.

I stratify the zero-cost returns on the basis of firm size to investigate the influence of firm size on momentum profits. In addition, the relationship between the momentum profits and Fama and French risk factors are tested using the Fama and French (1993) three factor model.

In contrast to Jegadeesh and Titman (1993) who used deciles based their study on a large number of stocks at the NYSE, the tercile approach in this study has been adopted because the NSE had a small sample of stocks over the study period (about 55 active counters). According to Hong *et al.*, (2000), a smaller portfolio composition like this should result in generation of better signal-to-noise properties for the tests.

3.2 Study Hypothesis

This study is designed to test the following null hypothesis:

Null Hypothesis:

a. Stocks at the NSE do not exhibit momentum anomaly. This means that the difference between Winner and Loser Portfolio is zero. In other words, winners portfolio do not outperform losers portfolio.
b. Firm size does not influence momentum profits. In other words, firms of different sizes contribute equally to any influence of firm size on momentum profits.
c. The factors in the Fama and French three factor model do not affect momentum profits.

3.3 Study Sample

The population of the study consists of all companies in all segments at the NSE for the eight year period between 2000 and 2007. The eight year study period is preferred because it offers sufficient data for the kind of analysis in this study.

Unlike other similar studies which eliminate companies with missing data, I include such companies but they do not participate in portfolio formation and returns if they have missing data over the formation / holding period. Appendix 1 gives sample firms in the study.

3.4 Data Collection

This study uses secondary data from the NSE. I obtain daily price lists for all stocks under consideration. From this I derive weighted monthly average prices. To compute the return, the previous month average price becomes the starting price for the next month, while the current price average becomes the closing price for the current month. The effect of dividends, share splits, bonus shares and rights issues are taken into account. I collect the 91-day Treasury bill rates from the Central Bank of Kenya (a proxy for risk free rate) and market returns (derived from the value weighted NSE 20 share index) which are later used for testing the 6-month/6-month strategies.

The derived data is then combined and aggregated in a panel format comprising cross-sectional data (many companies) with time series data (different observations for each company over the study period).

3.5 Data Analysis

The required data for this study covering the study period is collected at the NSE and extracted in a format suitable for the analysis. The data is analyzed in Stata and Eviews statistical packages. These packages were chosen because of their efficiency for this kind of analysis and the author's familiarity with the packages.

The momentum variable to predict returns for month j is the cumulated compounded J month return for the month's j - J to j - 2. Like much of the literature on momentum, and in particular Fama and French (2008), I skip the return for the month before the return to be explained because of negative correlation evidence in the literature (reversal rather than continuation) of month to month returns. Momentum variable is modeled as the cumulated continuously compounded stock return from month j - J to month j - 2, where j is the month of the forecasted return.

Based on the monthly average prices, simple returns are computed as follows.

$$R_t = \frac{P_t + D_t - P_{t-1}}{P_{t-1}}$$

Equation 2: Computation of Monthly Returns

Where

R_t is the simple return for a stock in a given month t

P_t is the start price for the stock in month t

P_{t-1} is the end price for the tock in month t

D_t is the dividend distribution for the stock in the month t

For the kind of analysis in this study, it much more convenient to use continuously compounded returns due to the additive property of multi-period continuously compounded returns. I define continuously compounded return for a period as follows. Let R_t denote the simple monthly return on an investment. The continuously compounded monthly return r_t is defined as:

$$r_t = \ln(1 + R_t)$$

Equation 3: Computation of Continuously Compounded Return

Given a monthly continuously compounded return, is straightforward to solve back for the corresponding simple net return. Therefore, nothing is lost by considering continuously compounded returns over simple returns.

$$R_t = e^{rt} - 1$$

Equation 4: Solving Back for Simple Return

The steps followed to construct portfolios and analyze the results are as follows:

Step 1: Computation of lagged returns

The continuously compounded J month return for each stock is the sum of the J continuously compounded one-month lagged returns, defined as follows.

$$r_l = \sum_{t=2}^{J} r_t$$

Equation 5: Computation of Lagged Return

I skip the immediate return for the month to be explained because of evidence in the literature of negative correlation (reversal rather than continuation) of month to month returns. For each of the strategy involved, J takes one of 3, 6, 9 and 12.

r_l is the cumulated lagged return for the stock.

t is the time

Step 2: Ranking of stocks and formation of portfolios

The stocks are ranked in ascending order on the basis of lagged returns obtained in step 1 above. They are then assigned to one of three tercile portfolios on a month by month basis.

I sort the sample into terciles based on past performance, i.e. : T1, which includes the worst performing tercile; T2 which includes the middle tercile; and T3 which includes the best performing tercile. the measure of momentum is then T3 - T1 which is also referred to as Winner minus Loser (WL) portfolio or the Zero cost portfolio.

Step 3: Computation of portfolio Returns

The portfolios are then held for K months where K is one of 3, 6, 9 and 12 depending on the strategy. The monthly return for each stock in the portfolio is averaged over the K months and the total divided by the number of stocks. The monthly return of the Winner portfolio is:

$$r_{wp} = \sum_{s=1}^{n} \left(\sum_{t=0}^{K-1} r_{wt} / K \right) / n$$

Equation 6: Return of the Winner Portfolio

And the monthly return on the loser portfolio is

$$r_{lp} = \sum_{s=1}^{n} \left(\sum_{t=0}^{K-1} r_{lt} / K \right) / n$$

Equation 7: Return of the Loser Portfolio

r_{wp} is the return on the winner portfolio; r_{lp} is the return on the loser portfolio

n is the number of stocks

t is the time

s is the stock

r_{wt} is the return on the stock included in the winner portfolio at time t; r_{lt} is the return on the stock included in the loser portfolio at time t

Taking the month for which the return on a stock is to be explained, it should be noted that the K month holding period takes the values 0 to K -1, since I include the current month. Note that the number of months is still K.

Step 4: Computation of return on zero cost portfolio

The return on zero-cost portfolio is obtained by subtracting the return for the Loser portfolio from the Winner portfolio.

$$r_{wp} - r_{lp}$$

Equation 8: Return of the Loser minus Winner Portfolio

Step 5: Analysis of results

The resulting data is then analyzed in stata and EViews statistical packages. They are summarized to obtain the means, standard deviations and other summary statistics. The t statistic is computed as follows:

$$t_{stat} = \frac{Mean}{Standard\ Error}$$

Equation 9: Computation of t-statistic

$$Standard\ Error = \frac{Standard\ Deviation}{\sqrt{n}}$$

Equation 10: Computation of Standard Error

Step 6: Decomposition of Momentum profits on the basis of firm size

The proxy for firm size will be the number of shares outstanding multiplied by the average price per share for the month. The firm size is used to decompose the excess returns for the 6-month/6-month strategy to investigate if firm size explains momentum. Using this, I assign another set of portfolios which are combined with the momentum portfolios to determine the effect of size on momentum anomaly.

Step 7: Testing for Fama and French risk Factors

Similar to Lishenga *et al* (2011), part of this study require testing the relationship between momentum profits and Fama and French risk factors using the Fama and French (1993) three-factor model. This model is given below.

$$(r_i - r_f) = a_i + b_i(r_m - r_f) + s_i SMB + h_i HML + e_i$$

Equation 11: Fama and French Three Factor Model

Where r_i is the monthly return for portfolio *i*; r_f is the monthly return on one-month treasury bill obtained from Central Bank of Kenya; r_m is the value-weighted NSE 20 index used as proxy for the market; SMB is the FF small firm factor; HML is the FF book-to-market (value) factor; b_i, s_i, h_i are the corresponding factor loadings; and a_i is the intercept or the alpha of the portfolio.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.0 Introduction

Based on the methodology outlined in the previous chapter, this section presents the analysis of results for the questions under investigation. A discussion of the results is also presented.

4.1 Returns of Relative Strength Portfolios

Table 1 gives the summary statistics obtained by forming J-month lagged returns and holding them for following K months. The values for J and K for the different strategies are indicated in the first column and row, respectively. The stocks are ranked in ascending order on the basis of their J-month lagged returns, skipping the month immediately before the stock whose return is to be explained.

An equally weighted portfolio of stocks in the lowest past return tercile is the Loser (L) portfolio of stocks and an equally weighted portfolio in the highest tercile is the Winner (W) portfolio of stocks. WL is the zero-cost, Winners minus Losers portfolio. The average monthly returns of these portfolios are presented in this table. The t statistics are reported in brackets. The sample stocks are drawn from the stocks that traded at the NSE for the period January 2000 – December 2007. See Appendix 1 for an insight into how the 6-month/6-month portfolios look like.

Table 1: Returns of Relative Strength Portfolios

J	K =	3	6	9	12
3	W	2.56% (5.0404)	2.39% (5.9745)	2.39% (6.7164)	2.28% (6.8936)
	L	1.15% (2.8089)	1.52% (4.4529)	1.62% (5.3138)	1.80% (6.5155)
	WL	1.41% (3.8690)	0.87% (3.7276)	0.76% (3.9155)	0.48% (2.8267)
6	W	2.78% (5.6195)	2.71% (6.7260)	2.57% (7.1695)	2.44% (7.2585)
	L	1.17% (2.9358)	1.36% (4.1492)	1.59% (5.3116)	1.75% (6.4989)
	WL	1.62% (4.1581)	1.35% (4.6241)	0.98% (4.3151)	0.69% (3.2085)
9	W	2.79% (5.2686)	2.69% (6.3189)	2.55% (6.7977)	2.42% (7.0076)
	L	1.40% (3.2406)	1.69% (4.9420)	1.89% (6.3176)	2.08% (7.6202)
	WL	1.39% (3.2049)	1.00% (3.4391)	0.66% (2.9140)	0.34% (1.7372)
12	W	2.85% (5.1819)	2.71% (6.2514)	2.55% (6.7150)	2.46% (7.1535)
	L	1.68% (3.8064)	1.93% (5.4919)	2.13% (6.7306)	2.29% (8.1614)
	WL	1.16% (2.5692)	0.78% (2.3726)	0.42% (1.6265)	0.17% (0.7573)

As can be seen in Table 1, all the zero cost portfolios yield positive returns which are statistically significant except the 12-month/12-month strategy (which gives an average return of 0.17% per month with t = 0.7573). The 6-month formation strategy yields higher monthly returns than any other formation strategy irrespective of the holding period (1.62%, 1.35%, 0.98% and 0.69%) respectively for 3-month, 6-month, 9-month, and 12-month holding periods. These results are consistent with earlier findings of Jegadeesh and Titman (1993) who reported returns of about 1% per month regardless of the holding period. The best performing strategy is the 6-month/3-month strategy whose zero-cost portfolio gives an average monthly return of 1.62 %.

Another notable observation is that the holding period of 3 months yields higher and significant monthly returns irrespective of the formation period. Longer holding periods seem to have an effect where the monthly stock returns reduce, or dissipate. The 3-month/3-month strategy has statistically significant monthly returns unlike those presented by Jegadeesh and Titman (1993) and Omuronji (2005).

4.2 Returns of Size based Relative Strength Portfolios

In this section I examine how momentum profits vary with firm size. I focus on the 6-month/6-month strategy within sub-samples stratified on the basis of firm size. I implement this strategy on three size based sub-samples (small, medium and large). This kind of stratification allows examination of profitability of the strategy confinement to any particular sub-sample of stocks.

Table 2 presents the average monthly returns of the 6-month/6-month strategy for each of the sub-samples stratified on size. The equally weighted portfolio of stocks in the lowest past return tercile is portfolio T1, the equally weighted portfolio of stocks in the middle tercile is portfolio T2 and the equally weighted portfolio of stocks in the highest past return tercile is portfolio T3. Average monthly returns and excess returns of these portfolios and the returns of relative strength portfolios formed using size-based sub-samples of securities are presented. The sub-sample S1 contains the smallest firms, S2 the medium size firms and S3 the largest firms. WL is the zero cost portfolio obtained as T3 – T1. The sample period is January 2000 – December 2007. t-statistics are reported in parentheses.

Table 2: Returns of the 6-month/6-month strategy stratified on the basis of firm size

Portfolio	**Firm Size**			
	S1	**S2**	**S3**	**All**
T1	1.46% (4.32)	1.18% (2.71)	1.45% (3.54)	1.36% (5.97)
T2	1.60% (4.39)	2.33% (5.06)	2.03% (5.05)	1.98% (8.38)
T3	2.45% (5.58)	2.81% (5.77)	2.88% (6.86)	2.71% (10.49)
WL	0.99% (2.21)	1.63% (3.67)	1.43% (4.72)	1.35% (5.80)

For the zero-cost, winners – losers (WL) portfolio, the sub-samples of firms with the lowest size generates the lowest abnormal returns. These results are statistically significant at 5% level. However, the sub-sample with the largest firms generates lower abnormal returns compared to the sub-samples of medium firms. In contrast, Jegadeesh & Titman (1993) observed that the sub-samples with the largest firms generated lower abnormal returns than all the other sub-samples.

4.3 Testing of Momentum Profits for FF Risk Factors

This section outlines the testing of Fama and French three factors using the equation:

$$(r_i - r_f) = a_i + b_i(r_m - r_f) + s_i SMB + h_i HML + e_i$$

Equation 12: Testing of Momentum Profits

Table 3 gives the correlation matrix of variables in the regressions. T3 – T1, T1, T2 and T3 are returns on the relative strength portfolios in excess of the risk free rate. *rm - rf* is the difference between the market return and the central bank 91-day treasury bill. SMB is the monthly difference between the returns of a portfolio of small stocks and the portfolio of big stocks. HML is the monthly difference between the returns of a portfolio of high BE/ME stocks and the portfolio of low BE/ME stocks.

As can be seen in the table, the market factor is highly correlated with all the dependent variables. All variables are positively correlated except the size factor (SMB) and the HML factor which are negatively correlated.

Table 3: Correlation matrix of variables in the Regression

	SMB	HML	rm – rf
SMB	1.000		
HML	-0.140	1.000	
rm – rf	0.194	0.226	1.000
T3 – T1	0.285	0.126	0.603
T3	0.438	0.291	0.730
T1	0.265	0.301	0.716
T2	0.226	0.265	0.762

Table 4 summarizes the regression results of the monthly returns for the 6-month/6-month momentum strategy in excess of the risk-free interest rate on the FF three-factors. Further details on the regressions can be found in Appendix 3.

T3 is the best performing tercile, T2 the portfolio in the middle tercile and T1 the worst performing tercile. t-statistics are reported in brackets. The last column gives the R-Squared.

As can be seen in Table 4, the coefficient of the HML factor is not significant from zero hence it does not influence momentum profits. The coefficients for the market and SMB factors are quite significant, though.

The estimated intercept coefficients from these regressions are interpretable as the risk-adjusted return of the portfolio relative to the three factor model. Cross checking these intercepts with the results presented in Table 1 shows that the results cannot be explained by the FF factors.

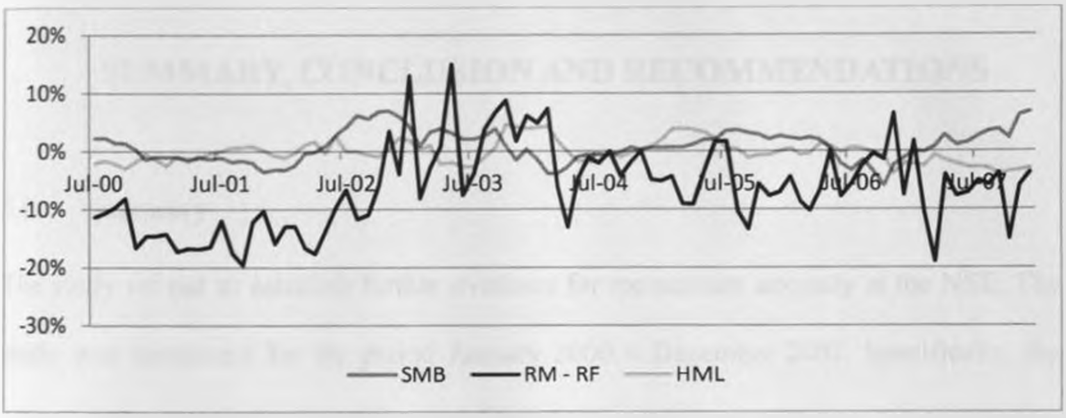
With Adjusted R^2 of 0.197 on the WL (T3 – T1) portfolio, the Fama and French factors can only explain about 20 % of the variation in the model. Thus the Fama and French three factor model cannot explain the profits of the momentum strategies for the selected strategy of 6-month/6-month.

Table 4: Risk Adjusted Excess Returns of 6-month/6-month Momentum Portfolios

	b_i	b_s	h_i	c	R^2
W	0.094423 (2.55)	0.469273 (2.84)	0.022242 (0.12)	0.001121 (0.55)	0.165
T2	0.055304 (1.60)	0.307912 (2.07)	0.333957 (2.12)	0.000213 (0.11)	0.099
L	0.021304 (0.72)	0.49195 (3.60)	0.3375 (2.38)	0.000247 (0.15)	0.188
WL	0.08392 (2.65)	0.484322 (3.13)	0.031015 (0.18)	0.00066 (0.34)	0.197

For a better insight into variation of independent variables over time, see Figure 1 which shows how the independent variables (SMB, HML and RM – RF) varied over the study period.

Figure 1: Graphical depiction of Independent Variables



CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Summary

The study set out to establish further evidence for momentum anomaly at the NSE. The study was conducted for the period January 2000 – December 2007. Specifically, the study sought to address the weaknesses identified by previous studies at the NSE, while incorporating recent research findings in stock markets around the world.

Omuronji (2005) had recommended that such studies should consider the use of average monthly prices, which has been used in this study. In addition, she recommended use of overlapping portfolios, which have also been used in the study. Wainaina (2007) carried out a similar study at the NSE but used a different methodology. In both cases, the authors observe evidence of momentum anomaly at the NSE. This study builds upon these two and extends evidence on momentum anomaly.

All the strategies yield positive abnormal returns with are statistically highly significant except the 12-month/12-month strategy. The 6-month formation strategy is the best performing strategy irrespective of the holding period: abnormal returns on portfolios formed on this basis outperform all other portfolios.

5.1 Conclusions

This study proves that there is continuation of stock returns in the medium term: stocks that perform well continue to perform well and stocks that perform poorly continue to perform poorly.

Based on the results, I reject the null hypotheses and conclude: first, stocks at the NSE exhibit momentum anomaly. Over the medium term, winners portfolio outperform losers portfolio. Secondly, the smallest firms generate the lowest abnormal returns. The sub-sample with the largest firms generates lower abnormal returns compared to the sub-samples of medium firms. Lastly, regressions show that the factors in the Fama and French three factor model have very little influence on momentum profits.

The results concur with findings from previous studies on momentum anomaly carried out at the NSE. The previous studies include Omuronji (2005), Wainaina (2007) and Lishenga et al. (2011).

5.2 Limitations of the Study

Like many other studies conducted at the NSE, one of the major limitations facing researchers is lack of access to accurate and up to date data and information. This study is no different, as I faced similar problems. Due to one reason or another, some counters such as LIMURU have no trading data over long periods. Availability of data for key events such as announcement and book closure dates for dividends, stock splits, issue of rights and bonus issues is lacking or inconsistent for the period earlier than 2004.

Very few studies have been done at the NSE focusing on Momentum anomaly. As a result, the body of knowledge available to draw inferences from is limited. The pioneering work by Omuronji (2005) was followed by Wainaina (2007) and more recently, Lishenga *et al.*, (2011) have conducted detailed studies of momentum at the NSE. This study attempted to show further momentum anomaly at the NSE

5.3 Areas for further Study

Momentum studies in other stock markets seem to cover more longer periods. For example, the seminal work of Jegadeesh & Titman (1993) covered the period 1965 – 1989. There is need to carry out the similar study at the NSE and cover a more extended period.

This study has uncovered an important finding: that firms whose size is small experience lesser momentum effect than larger firms. On the other hand, the largest firms have lesser momentum effect than medium size firms. A study could investigate this in detail to find out why this is the case.

This study has further provided existence of momentum anomaly at the NSE. It is however less clear what might be driving momentum. Some researchers have suggested a risk based interpretation of momentum. Others have advanced behavioral explanations. They suggest, for example, that prices initially overreact to news about fundamentals, and then continue to overreact further for a period of time. Examples of these include the positive-trader feedback model and the overconfidence model. In other models, momentum is a symptom of under-reaction – prices adjust too slowly to news. A study could be conducted at the NSE to find out which model best explains momentum.

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APPENDICES

Appendix 1: List of sample firms considered in the study (2000 – 2007)

	COMPANY		COMPANY
1	ACCESS	29	KENGEN
2	ARM	30	KENOL
3	BAMBURI	31	KENYARE
4	BAT	32	KPLC
5	BAUMANN	33	KQ
6	BBK	34	LIMURU
7	BOC	35	MARSHALS
8	CABLES	36	MUMIAS
9	CARBACID	37	NATION
10	CARGEN	38	NBK
11	CFC	39	NIC
12	CITYTRUST	40	OLYMPIA
13	CMC	41	ORCHARDS
14	CROWN	42	PANAFRICA
15	DTB	43	PORTLAND
16	EAAGADS	44	SAMEER
17	EABL	45	SASINI
18	EAPACKAGING	46	SCAN
19	EQUITY	47	SCBK
20	EVEREADY	48	STANDARD
21	EXPRESS	49	TOTAL
22	HFCK	50	TPS
23	HUTCHINGS	51	UCHUMI
24	ICDC	52	UNGA
25	JUBLEE	53	UNILEVER
26	KAKUZI	54	VIPINGO
27	KAPCHORUA	55	WILLIAMSON
28	KCB		

Appendix 2: Sample portfolios for the 6-month/6-month strategy

Month	T1	T2	T3	WL
2000m7	-1.64%	0.20%	-0.99%	0.65%
2000m8	-1.32%	-1.07%	-0.48%	0.84%
2000m9	-0.37%	-1.63%	-0.16%	0.21%
2000m10	-0.36%	-2.80%	-1.00%	-0.64%
2000m11	-2.22%	-2.34%	-0.80%	1.42%
2000m12	-3.03%	-1.68%	-0.77%	2.25%
2001m1	-2.74%	-0.76%	-0.25%	2.49%
2001m2	-1.27%	-2.44%	0.96%	2.24%
2001m3	-2.69%	-1.31%	-0.24%	2.45%
2001m4	-3.16%	-2.10%	-1.67%	1.49%
2001m5	-2.86%	-1.66%	-1.14%	1.72%
2001m6	-0.48%	-2.44%	0.30%	0.78%
2001m7	-1.49%	-1.75%	-0.97%	0.52%
2001m8	-1.57%	-1.93%	-1.25%	0.32%
2001m9	-1.22%	-1.36%	-0.89%	0.34%
2001m10	-0.35%	-1.55%	0.23%	0.58%
2001m11	-2.64%	-0.63%	-1.11%	1.53%
2001m12	-4.03%	-2.22%	-0.66%	3.37%
2002m1	-4.68%	-0.46%	-0.46%	4.22%
2002m2	-2.59%	-0.03%	-0.88%	1.71%
2002m3	-1.31%	-2.64%	-0.14%	1.17%
2002m4	-1.89%	-2.62%	1.38%	3.27%
2002m5	-1.39%	-0.24%	1.73%	3.12%
2002m6	2.27%	1.14%	2.85%	0.58%
2002m7	4.13%	1.03%	3.40%	-0.74%
2002m8	8.53%	1.89%	6.63%	-1.90%
2002m9	9.55%	2.64%	6.35%	-3.20%
2002m10	9.19%	3.53%	7.77%	-1.42%
2002m11	9.54%	3.25%	10.24%	0.70%
2002m12	8.90%	8.29%	12.61%	3.70%
2003m1	4.48%	9.40%	12.47%	7.99%
2003m2	2.09%	8.02%	6.32%	4.23%
2003m3	2.79%	7.30%	7.26%	4.47%
2003m4	4.24%	9.11%	7.92%	3.68%
2003m5	4.39%	9.92%	8.09%	3.69%
2003m6	2.67%	5.33%	3.72%	1.05%
2003m7	3.75%	7.03%	6.36%	2.62%
2003m8	3.14%	7.88%	9.42%	6.28%
2003m9	3.88%	9.37%	11.23%	7.35%

Month	T1	T2	T3	WL
2004m4	0.05%	-1.87%	-3.95%	-4.00%
2004m5	0.34%	-0.42%	-0.23%	-0.57%
2004m6	1.53%	-0.12%	1.94%	0.41%
2004m7	1.30%	1.13%	0.68%	-0.62%
2004m8	1.74%	1.21%	2.50%	0.76%
2004m9	1.34%	1.02%	4.39%	3.05%
2004m10	2.16%	1.58%	3.82%	1.66%
2004m11	0.93%	1.53%	4.29%	3.36%
2004m12	1.29%	1.91%	3.95%	2.67%
2005m1	3.14%	3.28%	7.41%	4.27%
2005m2	6.00%	4.82%	7.50%	1.50%
2005m3	5.18%	4.51%	6.23%	1.05%
2005m4	4.16%	4.10%	6.32%	2.16%
2005m5	3.63%	6.26%	5.75%	2.12%
2005m6	3.47%	4.79%	5.00%	1.53%
2005m7	1.42%	2.73%	2.10%	0.68%
2005m8	1.30%	0.21%	1.19%	-0.12%
2005m9	1.30%	0.80%	1.23%	-0.07%
2005m10	1.17%	0.76%	1.88%	0.71%
2005m11	0.24%	1.06%	1.51%	1.27%
2005m12	0.65%	2.57%	4.78%	4.13%
2006m1	0.11%	2.46%	4.45%	4.34%
2006m2	-0.39%	1.85%	3.97%	4.36%
2006m3	-0.07%	2.54%	6.04%	6.11%
2006m4	2.12%	4.23%	7.46%	5.34%
2006m5	2.34%	5.35%	9.03%	6.69%
2006m6	3.52%	7.19%	6.42%	2.89%
2006m7	5.29%	7.40%	4.12%	-1.17%
2006m8	4.97%	9.72%	5.88%	0.92%
2006m9	6.01%	6.18%	2.49%	-3.52%
2006m10	3.18%	1.27%	-2.51%	-5.70%
2006m11	2.25%	-0.12%	-1.07%	-3.33%
2006m12	-0.48%	-0.44%	-3.96%	-3.48%
2007m1	-0.99%	0.08%	-1.13%	-0.14%
2007m2	-1.66%	-1.64%	-1.00%	0.66%
2007m3	-0.10%	0.81%	-1.95%	-1.85%
2007m4	2.68%	3.10%	1.74%	-0.94%
2007m5	0.86%	0.73%	0.57%	-0.29%
2007m6	1.89%	1.13%	0.44%	-1.45%

2003m10	5.56%	7.74%	6.19%	0.63%		2007m7	0.50%	1.80%	-0.03%	-0.53%
2003m11	2.44%	4.74%	2.93%	0.49%		2007m8	0.48%	-0.47%	0.87%	0.39%
2003m12	2.27%	2.90%	2.20%	-0.07%		2007m9	-0.83%	-0.62%	1.66%	2.49%
2004m1	2.79%	1.99%	0.34%	-2.45%		2007m10	-2.97%	1.11%	0.38%	3.34%
2004m2	1.15%	0.66%	-1.39%	-2.54%		2007m11	-2.56%	4.36%	5.31%	7.87%
2004m3	1.13%	-2.14%	-4.07%	-5.20%		2007m12	0.22%	0.45%	7.04%	6.82%

Appendix 3 : Regressions of momentum profits vs FF three factors

EQUATION 1: RSS_L = a + b_m (rm_rf) + b_{smb} (SMB) + b_{hml} (HML) + e

1. Descriptive Statistics

	RSS_L	RM_RF	SMB	HML
Mean	-0.060766	-0.063629	0.008310	-0.002534
Median	-0.054000	-0.066500	0.007100	-0.004350
Maximum	0.045600	0.149400	0.069300	0.045800
Minimum	-0.176600	-0.196100	-0.059300	-0.039600
Std. Dev.	0.054801	0.073512	0.027081	0.020256
Skewness	-0.302926	0.477687	0.159398	0.539844
Kurtosis	2.208099	3.021308	2.753590	2.846752
Jarque-Bera	3.728111	3.424471	0.608808	4.459545
Probability	0.155043	0.180462	0.737563	0.107553
Observations	90	90	90	90

2. Correlations

	RSS_L	RM_RF	SMB	HML
RSS_L	1	0.716	0.265	0.301
RM_RF	0.716	1	0.194	0.226
SMB	0.265	0.194	1	-0.139
HML	0.301	0.226	-0.139	1

3. Estimated equation 1

Estimation Command:

=========================

LS DRSS_L DRM_RF DSMB DHML DRSS_L(-1) ECMA_1 C

Estimation Equation:

=========================

DRSS_L = C(1)*DRM_RF + C(2)*DSMB + C(3)*DHML + C(4)*DRSS_L(-1) + C(5)*ECMA_1 + C(6)

Substituted Coefficients:

=========================

DRSS_L = 0.02130409966*DRM_RF + 0.4919503231*DSMB + 0.3375001897*DHML + 0.296321298*DRSS_L(-1) - 0.1018586726*ECMA_1 + 0.0002467329111

Dependent Variable: DRSS_L				
Method: Least Squares				
Date: 10/19/12 Time: 10:06				
Sample(adjusted): 2000:09 2007:12				
Included observations: 88 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRM_RF	0.021304	0.029574	0.720373	0.4733
DSMB	0.491950	0.136595	3.601513	0.0005
DHML	0.337500	0.141592	2.383607	0.0195
DRSS_L(-1)	0.296321	0.105696	2.803512	0.0063
ECMA_1	-0.101859	0.055796	-1.825541	0.0716
C	0.000247	0.001685	0.146428	0.8839
R-squared	0.234922	Mean dependent var		0.000445
Adjusted R-squared	0.188271	S.D. dependent var		0.017529
S.E. of regression	0.015793	Akaike info criterion		-5.392760
Sum squared resid	0.020452	Schwarz criterion		-5.223851
Log likelihood	243.2814	F-statistic		5.035724
Durbin-Watson stat	1.976965	Prob(F-statistic)		0.000450

EQUATION 2: $RSS\_W = a + b_m (rm\_rf) + b_{smb} (SMB) + b_{hml} (HML) + e$

1. Descriptive Statistics

	RSS_W	RM_RF	SMB	HML
Mean	-0.047232	-0.063629	0.008310	-0.002534
Median	-0.042900	-0.066500	0.007100	-0.004350
Maximum	0.104000	0.149400	0.069300	0.045800
Minimum	-0.152100	-0.196100	-0.059300	-0.039600
Std. Dev.	0.056800	0.073512	0.027081	0.020256
Skewness	0.069375	0.477687	0.159398	0.539844
Kurtosis	2.472374	3.021308	2.753590	2.846752
Jarque-Bera	1.116155	3.424471	0.608808	4.459545
Probability	0.572308	0.180462	0.737563	0.107553
Observations	90	90	90	90

2. Correlation Matrix

	RSS_W	RM_RF	SMB	HML
RSS_W	1	0.730151698981	0.437977060252	0.290664884338
RM_RF	0.730151698981	1	0.193688150867	0.22590759855
SMB	0.437977060252	0.193688150867	1	-0.139496881686
HML	0.290664884338	0.22590759855	-0.139496881686	1

3. Estimated Equation 2

Estimation Command:

=========================

LS DRSS_WL DRM_RF DSMB DHML(-1) DRSS_WL(-3) ECMB_1 C

Estimation Equation:

=========================

DRSS_WL = C(1)*DRM_RF + C(2)*DSMB + C(3)*DHML(-1) + C(4)*DRSS_WL(-3) + C(5)*ECMB_1 + C(6)

Substituted Coefficients:

=========================

DRSS_WL = 0.09442328924*DRM_RF + 0.4692733405*DSMB + 0.02224209908*DHML(-1) - 0.008095105447*DRSS_WL(-3) - 0.1265064818*ECMB_1 + 0.001120955306

Dependent Variable: DRSS_W				
Method: Least Squares				
Date: 10/19/12 Time: 10:48				
Sample(adjusted): 2000:11 2007:12				
Included observations: 86 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRM_RF	0.094423	0.037062	2.547719	0.0128
DSMB	0.469273	0.165326	2.838475	0.0057
DHML(-1)	0.022242	0.180561	0.123183	0.9023
DRSS_W(-3)	-0.008095	0.108643	-0.074511	0.9408
ECMB_1	-0.126506	0.072241	-1.751181	0.0837
C	0.001121	0.002034	0.551094	0.5831
R-squared	0.213953	Mean dependent var		0.001307
Adjusted R-squared	0.164825	S.D. dependent var		0.020599
S.E. of regression	0.018825	Akaike info criterion		-5.040004
Sum squared resid	0.028352	Schwarz criterion		-4.868771
Log likelihood	222.7202	F-statistic		4.355022
Durbin-Watson stat	1.650652	Prob(F-statistic)		0.001479

Equation 3: $RSS\_WL = a + b_m (rm\_rf) + b_{smb} (SMB) + b_{hml} (HML) + e$

1. **Descriptive statistics**

	RSS_WL	RM_RF	SMB	HML
Mean	-0.060824	-0.063629	0.008310	-0.002534
Median	-0.067500	-0.066500	0.007100	-0.004350
Maximum	0.065200	0.149400	0.069300	0.045800
Minimum	-0.130600	-0.196100	-0.059300	-0.039600
Std. Dev.	0.040943	0.073512	0.027081	0.020256
Skewness	0.494933	0.477687	0.159398	0.539844
Kurtosis	3.000547	3.021308	2.753590	2.846752
Jarque-Bera	3.674376	3.424471	0.608808	4.459545
Probability	0.159265	0.180462	0.737563	0.107553
Observations	90	90	90	90

2. **Correlation Matrix**

	RSS_WL	RM_RF	SMB	HML
RSS_WL	1	0.602487801708	0.284507122714	0.125347546709
RM_RF	0.602487801708	1	0.193688150867	0.22590759855
SMB	0.284507122714	0.193688150867	1	-0.139496881686
HML	0.125347546709	0.22590759855	-0.139496881686	1

3. **Estimated equation 3**

Estimation Command:
=========================

LS DRSS_WL DRM_RF DSMB DHML ECMC_1 C

Estimation Equation:
=========================

DRSS_WL = C(1)*DRM_RF + C(2)*DSMB + C(3)*DHML + C(4)*ECMC_1 + C(5)

Substituted Coefficients:
=========================

DRSS_WL = 0.08392020085*DRM_RF + 0.4843216529*DSMB + 0.03101542089*DHML - 0.1532853636*ECMC_1 + 0.0006595673646

Dependent Variable: DRSS_WL				
Method: Least Squares				
Date: 10/19/12 Time: 11:02				
Sample(adjusted): 2000:08 2007:12				
Included observations: 89 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRM_RF	0.083920	0.031689	2.648252	0.0097
DSMB	0.484322	0.154884	3.127004	0.0024
DHML	0.031015	0.168529	0.184036	0.8544
ECMC_1	-0.153285	0.066200	-2.315485	0.0230
C	0.000660	0.001939	0.340101	0.7346
R-squared	0.233586	Mean dependent var		0.001034
Adjusted R-squared	0.197090	S.D. dependent var		0.020400
S.E. of regression	0.018280	Akaike info criterion		-5.111490
Sum squared resid	0.028069	Schwarz criterion		-4.971679
Log likelihood	232.4613	F-statistic		6.400338
Durbin-Watson stat	1.618057	Prob(F-statistic)		0.000152

Equation 4: $RSS\_T2 = a + b_m (rm\_rf) + b_{smb} (SMB) + b_{hml} (HML) + e$

1. **Descriptive Statistics**

	RSS_T2	RM_RF	SMB	HML
Mean	-0.054810	-0.063629	0.008310	-0.002534
Median	-0.055050	-0.066500	0.007100	-0.004350
Maximum	0.085400	0.149400	0.069300	0.045800
Minimum	-0.177400	-0.196100	-0.059300	-0.039600
Std. Dev.	0.058224	0.073512	0.027081	0.020256
Skewness	0.058701	0.477687	0.159398	0.539844
Kurtosis	2.577650	3.021308	2.753590	2.846752
Jarque-Bera	0.720611	3.424471	0.608808	4.459545
Probability	0.697463	0.180462	0.737563	0.107553
Observations	90	90	90	90

2. **Correlation Matrix**

	RSS_T2	RM_RF	SMB	HML
RSS_T2	1	0.761692876825	0.225810831915	0.264784386762
RM_RF	0.761692876825	1	0.193688150867	0.22590759855
SMB	0.225810831915	0.193688150867	1	-0.139496881686
HML	0.264784386762	0.22590759855	-0.139496881686	1

3. **Estimated equation**

Estimation Command:
=========================
LS DRSS_T2 DRM_RF DSMB DHML ECMD_1 C

Estimation Equation:
=========================
DRSS_T2 = C(1)*DRM_RF + C(2)*DSMB + C(3)*DHML + C(4)*ECMD_1 + C(5)

Substituted Coefficients:
=========================
DRSS_T2 = 0.05530373091*DRM_RF + 0.3079124751*DSMB + 0.333957252*DHML - 0.02598716263*ECMD_1 + 0.0002132321234

Dependent Variable: DRSS_T2
Method: Least Squares
Date: 10/19/12 Time: 11:19
Sample(adjusted): 2000:08 2007:12

Included observations: 89 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRM_RF	0.055304	0.034619	1.597518	0.1139
DSMB	0.307912	0.148866	2.068394	0.0417
DHML	0.333957	0.157476	2.120692	0.0369
ECMD_1	-0.025987	0.061532	-0.422336	0.6739
C	0.000213	0.001863	0.114473	0.9091
R-squared	0.140797	Mean dependent var		0.000369
Adjusted R-squared	0.099882	S.D. dependent var		0.018509
S.E. of regression	0.017560	Akaike info criterion		-5.191840
Sum squared resid	0.025902	Schwarz criterion		-5.052029
Log likelihood	236.0369	F-statistic		3.441252
Durbin-Watson stat	1.597694	Prob(F-statistic)		0.011796