LUND UNIVERSITY

SCHOOL OF ECONOMICS AND MANAGEMENT

Factor Premiums in Developing Stock Markets: Evidence from Nairobi Securities Exchange

Author: Agnes Lindvall

Master's in finance - 2019/2020

Master Essay

Supervisor: Thomas Fischer

Abstract

This study tests the Fama-French 5-factor asset pricing model in a developing stock market. The purpose is to investigate whether the size, value, profitability, and investment factor premiums exist in the Nairobi Securities Exchange (NSE). The test results of the Fama-French 5-factor model are compared with those of the Capital Asset Pricing Model (CAPM). Using monthly stock data for July 2009 to June 2019, value and profitability factors explain some variations in stock returns and improve the CAPM. Due to data insufficiency and limitations on the variables that affect the model, the existence of factor premiums in this market is inconclusive.

Keywords: Asset Pricing Models, Fama-French 5-factor Model, Nairobi Securities Exchange, Factor Premium

Acknowledgement

I would like to express my sincere gratitude to my thesis supervisor Thomas Fischer, for his advice and guidance in the writing process. I also thank Lars, Pearl, Jing, Noela, Lukas, and Per, for giving me endless encouragement and support during my studies.

Abbreviations

OP	Operating Profit
B/M	Book value to market value
INV	Investment
SH	Small High
SL	Small Low
BH	Big High
BL	Big Low
SR	Small Robust
SW	Small Weak
BR	Big Robust
BW	Big Weak
SA	Small Aggressive
SC	Small Conservative
BA	Big Aggressive
BC	Big Conservative
SMB	Small minus big
HML	High minus low
RMW	Robust minus weak
CMA	Conservative minus aggressive

Table of Contents

1 Introduction

Factor investing is a "systematic investment approach that targets specific attributes of securities" (Zaher, 2019, p.9). It is a process of integrating factor-exposure decisions into the process of constructing portfolios. Factor investing emerged in the 1970s when earlier assumptions of the Capital Asset Pricing Model (CAPM) as theorized by Treynor (1961, 1962), Sharpe, (1964), Lintner, (1965), Mossin (1966), and Black (1972) were being challenged by empirical research findings whereby factors, other than the market risk premium, could explain stock returns.

The guiding blocks of factor investing in the equity markets are the factor premiums. These factor premiums are size (small stocks), value, profitability, investment, low volatility, quality, and momentum (Zaher, 2019). These factors have proved to yield higher returns than investing in a stock market index. Factor investing can be implemented as a form of diversification for investors as opposed to allocating investments traditionally by diversifying through asset classes such as stocks, commodities, currencies, private equity, and real estate.

When an investor decides to implement a factor investing strategy based on the size factor, a portfolio is constructed based on the exposure to stocks with small market capitalization. Research has shown that stocks with small market capitalization outperforms those with big market capitalization (Banz, 1981). Similarly, a low volatility factor is attained by exposure to a portfolio of stocks with a low volatility (Haugen & Heins, 1972) as such stocks have proved to outperform stocks with high volatility.

1.1 Problem discussion

Due to the availability of reliable financial data at very low costs in modern times, empirical studies have been conducted to determine significant factors that yield higher excess returns in equity markets around the world. Many of these studies examining factor premiums are focused in studying factors prevalent in developed equity markets. Empirical studies by Fama and French (1993, 2015, 2017) are tested on data from US and 22 other developed equity markets. There is a lack of empirical studies that investigate factor premiums that prevail in developing equity markets. This calls for a research opportunity to discover the untapped power of factor investing in developing markets. It is worthwhile to investigate whether factors that have proved to generate excess stock returns in developed markets apply in developing stock markets as well.

More evidence is needed to entice investors to view developing equity markets as unexploited investment opportunities both for equity and fixed income, or as a diversifying alternative, especially with the current low stock market premiums in developed equity markets, and negative interest rates in Europe. The limited availability of reliable financial data could be a deterrent in conducting research studies in emerging and developing equity markets.

1.2 Purpose

The purpose in this study is to investigate the Fama and French (2015) 5-factor asset pricing model to determine whether size, value, profitability, and investment factor premiums exist in a developing equity market. The market of interest in this study is the Nairobi Securities Exchange (NSE) in Kenya, using data from the sample period between 1 January 2008 to 30 June 2019. No prior Fama-French 5-factor model studies exist in this market. The key focus is comparing the performance of the Fama-French 5-factor model in the Kenyan stock market with results of CAPM to determine whether additional risk factors improve the explanatory power of CAPM. This empirical study contributes towards identifying factors that are significant for factor investing in developing equity markets.

1.3 Research question

The research question is whether additional factors, other than the market risk factor in CAPM, significantly explains the stock returns in the Nairobi Securities Exchange, a developing equity market faced with illiquidity, mispricing, and not properly regulated by authorities.

Results show that value and profitability factor premiums explain some variation in stock returns significantly, hence the existence of factor premiums cannot be rejected. The size and investment factors could not be tested due to limited data in the sample. The value and profitability factors improve CAPM significantly.

1.4 Outline

The section that follows briefly explains Kenya's economy, followed by a background of the Nairobi Securities Exchange. Section three provides a literature review on asset pricing models and on the implementation of the Fama-French 5-factor model in different markets and regions. Section four is an explanation of the data and methodology used in this study. Empirical results and interpretations are in section five. Section six summarizes the findings and discusses data limitations encountered when conducting this study. The conclusion is in section seven.

2 Brief Overview of Kenya

2.1 Economic overview

Kenya is the financial hub of the East Africa Community countries, namely Tanzania, Uganda, Rwanda, Burundi, and South Sudan (Central Intelligence Agency, 2020). The country is grouped by the International Monetary Fund as an emerging developing country. It has a population of 51.4 million people as of 2018. Most of it is young as 60% of the population is under the age of 25 (International Monetary Fund, 2020).

The major sectors driving the economy of Kenya are agriculture, services (financial, tourism), manufacturing (industry), infrastructure development, mining, and energy (Central Intelligence Agency, 2020). Sectors that are top contributors to the growth of Kenya's Gross Domestic Product (GDP) are services, agriculture, and industry (Appendix A.1). The agricultural sector employs more than 60% of the 19.6 million people who are in the formal labour force, while the services sector employs 32% (Central Intelligence Agency, 2020).

Kenya's annual average GDP growth over a span of 58 years, between 1961 and 2018, before adjusting for inflation, is 5%. Within this period, it attained the lowest GDP growth rate (-8%) in 1961 and achieve the highest GDP growth rate (22%) in 1971. The real GDP growth of Kenya between 1980 and 2020 is shown in Figure A.2 in the Appendix.

Between 1 July 2009 and 30 June 2019, the average monthly inflation rate was 7%, according to the Central Bank of Kenya (Appendix A.3). April 2011 to June 2012 was a period of high inflation rates, ranging between 10% to 20% (Appendix A.4). Since late 2012, inflation rates have been stable and not exceeded 10% as shown in Figure 1 (Central Bank of Kenya).

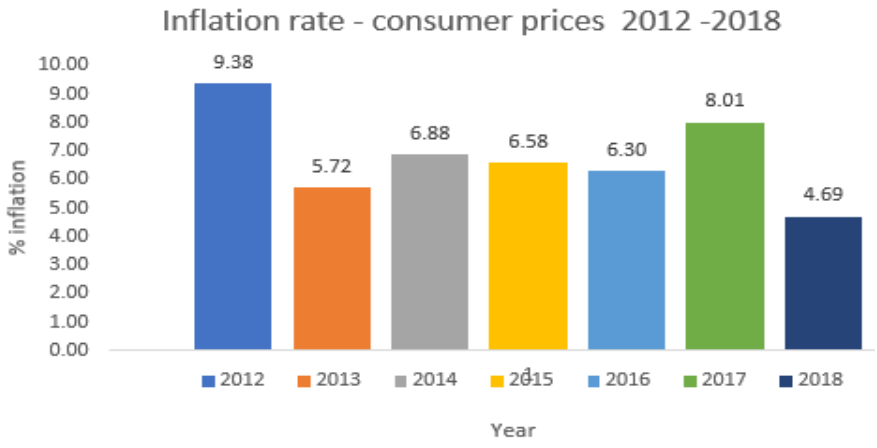

Figure 1: *Average monthly consumer prices inflation rates for Kenya between 2012 and 2018*

The Central Bank of Kenya issues Treasury bills (T-bills) with 91, 182 and 364-day maturities. The discount rates of these T-bills are as volatile as the inflation rates. Figure 2 shows the monthly average T-bill rates and monthly inflation rates between 2009 and 2019.

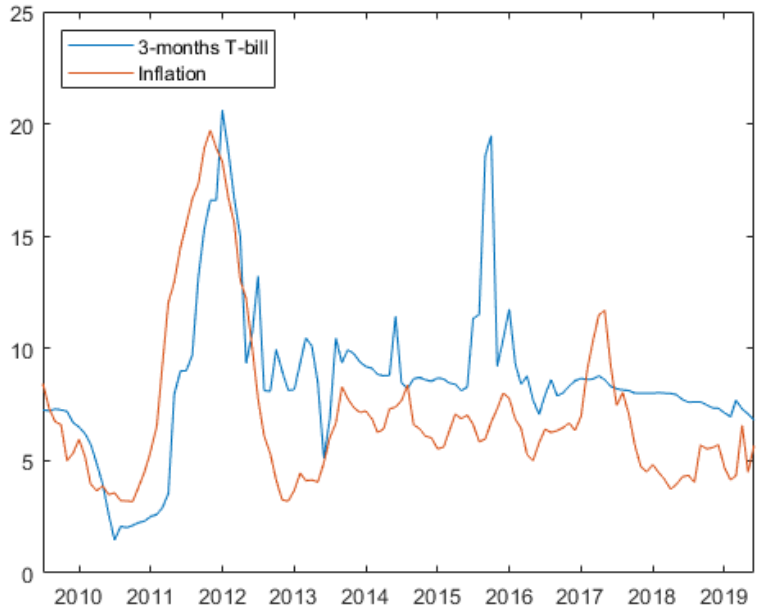

Figure 2: *Central bank of Kenya Monthly Treasury Bills Rate & Monthly Inflation Rates*

The highest discount rate was at 27% in October 1997. T-bill rates have been relatively stable since 2016 with rates ranging between 6% and 9%, and inflation rates averaging 6% during the same period. Figure 3 shows T-bill rates (Real T-bills) after adjusting for inflation.

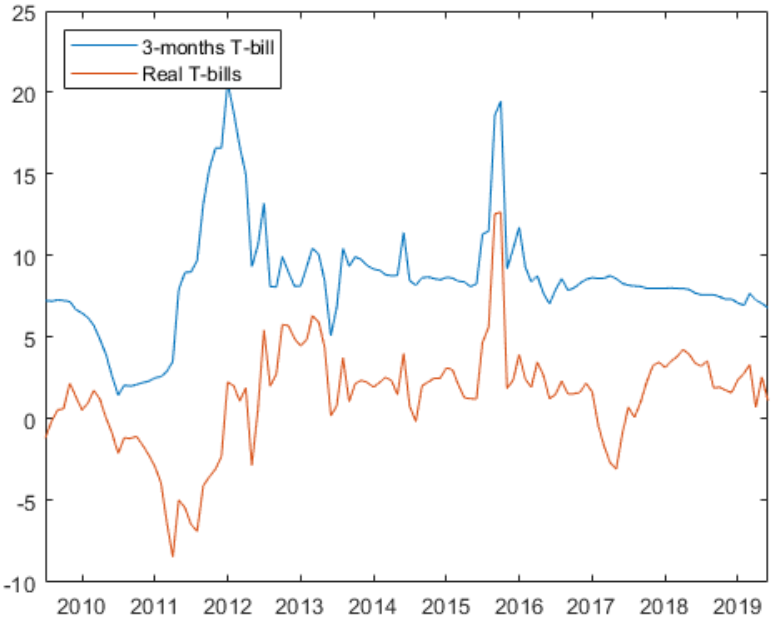

Figure 3: *T-bill rates between July 2009 and June 2019 rate after adjusting for inflation*

2.2 A Background of the Nairobi Securities Exchange

The Nairobi Securities Exchange (NSE), formerly known as Nairobi Stock Exchange, was officially registered in 1954 as a voluntary association of stockbrokers in Kenya (NSE, 2020). The purpose was to develop a securities market that regulates stock trading activities in the British colony of Kenya.

When the government of Kenya decided to transfer economic and social control to the citizens in the years following independence from colonial rule, 66 public industrial sector securities from Kenya, Uganda, and Tanzania were listed on the NSE, which was the regional capital market. It was a period of free cross-border movement of capital for the three members of the East African Federation (NSE, 2020).

The changing political climate and the collapse of the East Africa Federation led to the delisting of Ugandan and Tanzanian securities from the NSE. While Tanzania and Uganda were nationalizing private entities in the 1980s, state-owned companies were being privatized in Kenya. Privatization is seen as a shift from political goals to economic goals (Poole, 1996).

As part of the 1980s privatization movement in Kenya, Kenya Commercial Bank (KCB), a state-owned enterprise, sold 20% of its shares to the public in 1988, a step that paved way for major Initial Public Offerings (IPOs) such as Total, National Printers and Standard Chartered Bank stocks in the years that followed. The International Finance Corporation (IFC) named NSE the best performing stock market globally with a 179% return in dollar terms in 1994 (NSE, 2020).

The 1990s was a decade of high expectations for the growth of the domestic capital market in Kenya and other developing countries. Benefits from the capital markets were expected to pour back to the local economy through matching long-term investments with long-term capital needed by agricultural, manufacturing, financial, and trading companies that were prospering as the population grew, literacy rates increased and employment income grew. People started saving excess income through pension funds, which in return was invested on the NSE (NSE, 2020).

Companies listed on the NSE cover 12 sectors: agricultural, automobiles and accessories, banking, commercial and services, construction and allied, energy and petroleum, insurance, investment, investment services, manufacturing and allied, telecommunication and technology, real estate investment trust (Table A.1 in the Appendix). 39% of the companies listed on the NSE are within the financial sector (Banking, Investment, Investment Services, Insurance, Real Estate Investment Trust). An Exchange Traded Fund (ETF) has recently been introduced.

For developed economies, well organized capital markets such as the London Stock Exchange are among the largest sources of finance for major companies. For Sub-Saharan African countries like Kenya, the development of the Nairobi Securities Exchange (NSE) is not that of a successful source of finance for companies listed in it due to illiquidity, poor regulations, and poor trading infrastructure (Tarhan, 2005). For a market like the NSE, lack of new listings for a number of years, and one dominating stock in terms of market value, are the major setbacks.

Between 1984 and 2005, a total of 48 companies were listed on the NSE. These listings raised 50 Billion Kenyan shillings (467.6 million USD) for the companies, which was a new record amount at that time.

By 2008, 55 companies were listed after five Initial Public Offerings (IPO) and two introductions. In 2015, 64 listings were actively trading. In May 2020, the number of active listings is 60 after two companies listed, two delisted within the same period, and four suspended.

New trading technologies have been slow to penetrate the trading floor of the NSE. When the stock exchange implemented live trading in 2006 by using an automated trading system, trading hours extended to three hours from two hours. A year later would see an implementation of remote trading which enable brokers and investment bankers to access the market in the comfort of their office premises. Trading hours have since extended to six hours.

The dominance of the market by few stocks creates a negative atmosphere for the stock exchange. Shares of Safaricom, a listed telecommunication company on the NSE, constitutes more than 40% of the listed shares (Table A.1 in the Appendix). During the Safaricom IPO in June 2008, listed shares increased from 15 billion to 55 billion.

3 Literature Review

3.1 Capital Asset Pricing Model

The starting point in asset pricing models is the Capital Asset Pricing Model (CAPM) as theorized by Treynor (1961, 1962), Sharpe, (1964), Lintner, (1965), Mossin (1966), and Black (1972). An asset pricing model attempts to define the relationship between excess return and systematic risk of an asset or group of assets. CAPM is among the earliest asset pricing models that tried to explain the risk-return relationship and is still widely used today.

According to CAPM, the stock performance is explained by only one factor, the market risk premium. The higher the risk, the higher the expected return. The expected return of asset *i* is the sum of a risk-free rate *Rf* and a market risk premium. The risk premium is the product of a beta coefficient βi of the market m, and the difference between the expected return from a market portfolio *E(Rm)* and *Rf*.

$$E(Ri) = Rf + \beta i,m[E(Rm) - Rf], \text{ where } i = 1,...,N$$

Over the years, other risk factors that seem to better explain excess return above what the market portfolio offers have been identified. One among the earliest studies that pointed out the possibilities of multiple factors in asset pricing models is Arbitrage Pricing Theory (APT), a multi-factor asset pricing model developed by Ross (1976). APT argued that there are multiple factors that can explain excess stock returns unlike what the one-factor CAPM theorized.

3.2 Multiple risk factors

Unsatisfactory results of CAPM in empirical studies conducted on the large quantities of financial data led to multi-factor models. Academic literature in support of the existence of factor premiums in equity markets has led to more factors that yield excess return to be discovered. Haugen and Heinz (1972) found that the risk-return relationship is non-linear and low-volatility stocks yield higher returns, contrary to CAPM, leading to the low-volatility factor investing phenomenon. Basu (1977) found that stocks with higher earnings-per-price ratio yield higher average returns compared to those with low earnings-per-price ratio.

The size factor by Banz (1981) is argued that returns are higher for stocks with low market capitalization compared to stocks with high market capitalization, establishing that there is a size premium where small market cap stocks outperform large market cap stocks. The

momentum factor was coined by Jegadeesh and Titman (1993) after proving that stocks that were leading in performance in the past are likely to be future winners.

The Arbitrage Pricing Theory (APT) by Ross (1976) and Fama and French (1992,1993) 3-factor model and later the 5-factor model (Fama and French, 2015) improved the performance of CAPM. The 3-factor model by Fama and French (1993) combined the factors; market-risk, size, and value, and found them to having significant explanatory powers on excess stock returns. These findings contradicted earlier asset pricing models of Sharpe (1964), Lintner (1965) and Black (1972) since market risk as portrayed by CAPM is not the only factor that explain excess stock returns. The one-factor CAPM did not explain all the average asset returns. Advanced models were needed to capture the unexplained average returns.

The proposed 3-factor model by Fama and French (1993):

$$R_i - Rf = \alpha_i + \beta_i(Rm - Rf) + s_i SMB + h_i HML \qquad \text{where } i = 1,...,N$$

R_i defines the return on portfolio *i*, *Rf* if the risk-free rate, *Rm* - *Rf* is the market portfolio return *Rm* minus the risk-free rate *Rf*. *SMB* is the difference between the average returns on a portfolio of small market capitalization stocks and big market capitalization stocks. *HML* is the difference between the average return of a portfolio of high and low book-to-market stocks.

The coefficients in the model, α, β, s, h are true values rather than estimates. The intercept α is zero if the factor exposures sufficiently capture all variations in expected stock returns.

An empirical study by Titman, Wei and Xie (2004) and Novy-Marx (2013) produced results that contradicted the Fama-French 3-factor model. The evidence showed the model to be incomplete because much of the variations in average returns related to profitability and investment were ignored.

Fama and French (2015) added profitability and investment factors. They found that the 5-factor model performed better that the 3-factor but with the main problem being the model's:

> failure to capture low average returns on small stocks whose returns behave like those of firms that invest a lot despite low profitability. The model's performance is not sensitive to the way its factors are defined. With the addition of profitability and investment factors, the value factor of the FF three-factor model becomes redundant… (Fama & French, 2015, p.3)

The proposed 5-factor time-series regression model is:

$$R_i - Rf = \alpha_i + \beta_i(Rm - Rf) + s_iSMB + h_iHML + r_iRMW + c_iCMA$$

The factors *Ri, Rm - Rf, SMB,* and *HML* are the same as in the 3-factor model. Additional factor The *RMW* is the difference between the average returns of a portfolio of stocks with robust and weak profitability. The *CMA* is the difference between the average returns of a portfolio of stocks of low investment firms (conservative) and high investment firms (aggressive).The hypothesis is that if the exposures to the five factors capture all variations in expected stock returns, then the intercept α_i is zero for all portfolios. The factors in this model are portfolios providing different combinations of Size, Value, Investment, and Profitability factor exposures

3.3 Fama-French 5-factor model performance

The Fama-French 5-factor model has been tested in North America, Europe, and some emerging market countries, but not in African countries except for South Africa which falls under the emerging markets category. Results from these studies vary widely, such that a factor that is significant in one market may not be significant in another.

Emerging and developed markets where the Fama-French 5-factor model has been applied include: China, India, Egypt, Malaysia, South Africa, as well as developed markets of Australia, South Korea, and Singapore (Mosoeu and Kadongo, 2019). The study found that the profitability factor is the most useful in explaining stock returns while the market factor is found to be insignificant. In contradiction, results of Mosoeu and Kadongo (2019) shows that firms with big market capitalization outperformed small market capitalization firms. Furthermore, the average return in growth stocks exceeded that of value stocks. This led to the conclusion that stocks of aggressive firms are superior to stocks of firms that invest conservatively. The mixed results led to the authors rejecting the 5-factor asset pricing model as not being suitable for pricing equities in emerging markets.

When the performance of the model was tested on the Johannesburg Stock Exchange and compared to results from the 3-factor model in the same market by Cox and Bitten (2019), they found that only the profitability factor seemed to improve the performance of the model. The investment factor seemed to have no power in explaining excess stock returns.

Chen et al. (2017), Zhang et. al., (2018) and Guo et al., (2017) implemented the model in the Chinese stock market. Chen et al. (2017) found that the performance of the portfolios

constructed based on the five factors were sensitive to market fluctuations of the stock market sentiments. Zhang et. al., (2018) using 495 A-shares from Shanghai found the 5-factor model to be applicable in China. Comparing these findings to the Fama-French 3-factor model, the 5-factor model was less effective. Guo et al., (2017) found strong patterns in the average stock returns in size, value, and profitability factors but weak patterns in the investment factor.

Fama and French, (2017) extended their 5-factor model that was conducted using US stocks. In the international test of the 5-factor asset pricing model, they included 23 developed markets in four regions: North America (United States, Canada), Japan, Europe (Austria, Italy, Belgium, the Netherlands, Denmark, Norway, Finland, Portugal, France, Spain, Germany, Sweden, Ireland, Switzerland, Israel, United Kingdom) and Asia Pacific (Australia, New Zealand, Hong Kong, Singapore).

They found that average stock returns increase with the increase in book-to-market ratio (value factor) and increase in operating profit (profitability factor) as expected. On the contrary, they found the investment factor to be negatively related to the average stock returns. Interesting results found that the investment factor is redundant for Europe and Japan such that dropping the investment factor from the 5-factor model had little effect in describing average returns in these markets. They highlighted the persistent problem of the 5-factor model in failing to fully capture average returns of small stocks with low B/M that behave like firms with weak profitability, but investing aggressively

Implementing the model using Australian stocks, Chiah et al. (2016) found the 5-factor model to be superior to the 3-factor model in explaining excess stock returns in the Australian stock market. Huynh (2017) approached the Australian stock market to explain anomalies with the 5-factor model and drew the conclusion that there is still room for a better asset pricing model because there are still some unexplained returns in the model.

Dirx and Peter (2018) implemented the model in CDAX stocks and found no significant explanatory powers from the profitability and investment factors, which led to their conclusion that the 5-factor model is not applicable in the case of the German stocks. After testing the model in the Istanbul Stock Market Sustainability Index in Turkey, Zeren et al (2019) support the validity of the profitability factor as an additional factor to the original 3-factor model but not the investment factor. The coefficients of the investment factor were not statistically significant for the sample data used.

4 Data and Methodology

4.1 Method

The research methodology of this empirical study follows that of Fama and French (2015). This study is an out-of-sample test for the Fama-French 5-factor asset pricing model in the Kenyan stock market. The method used in analysing the portfolios to estimate the coefficients of the factors in the model is the Ordinary Least Square (OLS) method.

4.2 Sample period

This study uses 58 stocks data from the Nairobi Securities Exchange taken between July 2009 to June 2019. In forming 12 portfolios, accounting data used is for December 2008 to December 2017.

4.3 Stock returns and accounting data

Monthly stock prices for July 2009 to June 2019 were obtained from DataStream. Monthly stock returns are obtained by taking the stock price at time t minus the stock price at time t-1. A total of 120 stock return observations are obtained.

To enable the construction of portfolios for the model, market capitalization, price-to-book value, operating profit per share, book value per share and total assets data for 58 stocks listed on the Nairobi Securities Exchange were obtained from DataStream and Bloomberg for the period covering January 2008 to December 2017;.

Due to a small sample size, delisted companies are also included in the study for the years they were listed. By including delisted stocks for the years in which they were still active, survivorship bias is mitigated (Elfakhani & Wei, 2003). The equities included in the data sample are those that have been listed on the Nairobi Securities Exchange for not less than 3 years. When filtering the accounting information, 2x2 sorts on size-B/M, Size-OP and Size-INV data between January 2008 to December 2017 was used to construct 12 value-weighted portfolios.

Based on the accounting information of 58 Nairobi Securities Exchange listed or delisted companies, *Size* data is sorted from small to big market capitalization stocks every year between December 2008 to December 2017.

B/M is obtained by the reciprocal of price-to-book equity and sorted annually from the highest to lowest value. *OP* is obtained by annually filtering the ratio of operating profit to book equity from highest (robust profitability) to lowest value (weak profitability).

INV variable is the total asset growth in one year divided by total assets in the previous year and the ratios are filtered from lowest (conservative) to highest (aggressive) asset growth ratio.

The breakpoint of the data is the median which groups the data for all variable into two groups. The filtering process is repeated each year based on accounting data from December 2008 to December 2017.

4.4 Risk-free interest rate (R_f) and Market portfolio (R_m)

Rf and Rm to be used in the Fama-French 5-factor model are proxied by the monthly average interest rate of the 91-day Central Bank of Kenya T-bill and the NSE 20 share index respectively. Data for Rf is obtained from the Central bank of Kenya website and the NSE 20 share index prices are from Bloomberg. Both variables are adjusted for inflation accordingly.

4.5 Factor definitions

4.5.1 Size factor (SMB)

The SMB is obtained by considering the market capitalization of companies in the stock exchange. To obtain market capitalization, the number of shares outstanding at the end of the period are multiplied by their market price. The hypothesis with regards to this factor is that small stocks outperform large stocks.

4.5.2 Value factor (HML)

The HML considers book equity to market equity ratio. The assumption is that value stocks with a high book equity to market equity outperform growth stocks which are stocks with low book equity to market equity.

4.5.3 Profitability factor (RMW)

The RMW is based on the operating profit divided by the book value of equity. The assumption is that stocks of highly profitable companies perform better that stocks of low operating profitable companies.

4.5.4 Investment factor (CMW)

The CMA is the annual growth rate of total assets of year t-1 divided by total assets at year t-2. The assumption is that stocks of companies with high total asset growth have below average stock returns.

The 5-factor model of Fama and French (2015) is described according to the following regression and defined according to the definitions in Table 1:

$$R_i - Rf = \alpha_i + \beta_i(Rm - Rf) + s_iSMB + h_iHML + r_iRMW + c_iCMA$$

Table 1: *A definition of dependent and independent variables in the 5-factor model*

Variables	**Symbol**	**Definitions**
	Dependent variable	
Risk premium	Ri - Rf	Stock return minus Risk-free interest rate
	Independent variables	
Alpha	α	Intercept
Market risk premium	Rm - Rf	Market portfolio return minus risk-free interest rate
Size	SMB	Small stocks minus big stocks in terms of market capitalization
Value	HML	High minus low in terms of book-to-market equity ratio
Profitability	RMW	Robust minus weak in terms of profitability
Investment	CMA	Conservative minus aggressive in terms of growth rate of total assets

4.6 Construction of portfolios

At the end of year t-1, independent sorts are used to assign stocks to two groups of each factor: Size group (Small (S) or Big (B)), B/M group (High (H) or Low (L)), OP group (Robust (R) or Weak (W)), and INV group (Conservative (C) or Aggressive (A)). The intersections of Size-B/M, Size-OP and Size-INV groups are the building blocks for the portfolios. The median is used as the breakpoint.

To construct the Size-B/M portfolios at the end of June each year, stocks are allocated to two size groups (small and big) and independently sorted to two groups of B/M groups (low and high) using median as the break point. The left-hand side variables are the 4 Size-B/M portfolio intersections (SH, SL, BH, BL) and the right-hand side variables are the five factors. The same process is repeated for Size-OP and Size-INV portfolios.

Due to few observations in this study, 58 stocks and 120 observations, the sorting of stocks for portfolio construction to test the 5-factor model follows 2x2 sort used by Fama and French (2015). The authors suggested factors from the 2x2 Size-B/M, Size-OP and Size-INV sorts over

the original sorting approach of 2x3 because the 2x2 sorted factors are better diversified. Factors from the 2x2 sorting approach makes use of all stocks without exclusion, while 2x3 sorts excluded 40% of the stocks (Fama & French, 2015).

The 2x2 sorts are labelled by 2 letters and defined in the Abbreviations. The intersection of this sort produces 12 portfolios. Table 2 shows the number of stocks in each portfolio held between July of year t to June of year t+1. The portfolios are rebalanced annually.

Table 2: *Intersection of 2 x 2 sorts showing the number of stocks held in each portfolio with annual rebalancing*

Year	SH	SL	SR	SW	SC	SA	BH	BL	BR	BW	BC	BA	TOTAL
2008	15	6	5	16	11	9	9	14	15	7	9	12	128
2009	14	9	6	13	10	12	11	13	15	6	12	11	132
2010	15	7	8	14	12	10	9	15	16	6	11	13	136
2011	19	6	9	15	14	9	7	18	15	10	11	14	147
2012	16	9	9	13	13	11	10	16	16	10	11	15	149
2013	17	8	7	15	15	8	8	19	17	10	9	18	151
2014	18	8	8	16	16	9	6	20	17	10	9	18	155
2015	18	8	8	16	16	10	8	18	17	9	9	17	154
2016	15	11	7	19	12	12	11	16	19	8	12	15	157
2017	16	10	5	19	17	9	11	16	20	7	9	18	157
Average	16	8	7	16	14	10	9	17	17	8	10	15	147

Stocks are sorted according to two factors and held for one year at a time between July and June. Portfolios are constructed between July 2009 to June 2019 based on information between December 2008 to December 2017. The portfolios are constructed based on Size, Book Equity/Market Equity, Profitability, and Investment factors. The reason why portfolios are constructed from July is to ensure that accounting information for the previous year is available and this helps to mitigate the look-ahead bias.

Once the stocks in each portfolio are known, the monthly returns of each stock in the portfolio is obtained by taking the difference of the stock prices between month t and t-1. The average of the monthly stock returns for all stocks in the portfolio between July year t to June year t+1 is obtained. Since each portfolio is held for 12 months and rebalanced annually, the same process is repeated for all 12 portfolios for a total period of 10 years.

The factors constructed are SMB (small minus big Size), HML (high minus low Book/Market Equity), RMW (robust minus weak Operating Profit), and CMA (conservative minus

aggressive Investment). The SMB portfolio is constructed by taking a long position in the six Small stock portfolios and a short position in the six big stock portfolios. HML is constructed by taking a long position in the two portfolios with high B/M loadings and a short position in the two portfolios with low loadings. RMW is constructed by taking a long position in the two portfolios with robust profitability loadings and a short position in the two portfolios with weak profitability loadings. Finally, CMA is constructed by taking a long position in the two portfolios with conservative investment loadings and a short position in the two portfolios with aggressive investment loadings.

Table 3: *How factors are constructed on annually rebalanced 12 portfolios*

Sorts	**Factors**	**Components**
2X2 sorts on:		
	Size	SMB = (SH + SL + SR + SW + SC + SA)/6 - (BH + BL + BR + BW + BC + BA)/6
Size and B/M	**Value**	HML = (SH + BH)/2 - (SL + BL)/2
Size and OP	**Profitability**	RMW = (SR + BR)/2 - (SW + BW)/2
Size and Inv	**Investment**	CMA = (SC + BC)/2 - (SA + BA)/2
Breakpoints for each factor is the median		

5 Empirical Results and interpretations

5.1 Left-hand-side portfolios (LHS)

LHS variables are the 12 portfolios that are to be explained by the Fama-French 5 factors. They are constructed between July of year *t* to June of year *t+1* based on accounting data as at December year *t-1*. The portfolios sorted in groups of 2X2 are SH, SL, BH, BL; SR, SW, BR, BW; and SC, SA, BC, and BA. Table A.2 in the Appendix outlines a detailed summary of the factors. Table 4 summarizes the average percent returns, standard deviation, maximum and minimum returns, Sharpe ratio and beta of each of the 12 portfolios.

Table 4: *Descriptive statistics for 12 portfolios*

Panel A	SL	SH	BL	BH
Mean	-1.005	-0.541	-0.554	-1.361
Std. dev	5.573	5.120	4.584	5.465
Max	16.477	23.760	10.245	15.216
Min	-16.282	-9.585	-14.845	-17.780
Sharpe ratio	-0.180	-0.106	-0.121	-0.249
Beta	0.679	0.674	0.889	1.046
Panel B	SW	SR	BW	BR
Mean	-0.419	-1.337	-0.984	-0.814
Std. dev	5.009	5.814	5.420	4.804
Max	21.075	13.596	11.274	12.738
Min	-11.250	-13.637	-17.727	-15.384
Sharpe ratio	-0.084	-0.230	-0.182	-0.169
Beta	0.699	0.633	0.989	0.922
Panel C	SA	SC	BA	BC
Mean	-1.102	-0.406	-0.976	-0.685
Std. dev	5.227	5.630	5.036	4.760
Max	18.260	27.650	12.474	11.434
Min	-12.243	-11.602	-17.830	-13.513
Sharpe ratio	-0.211	-0.072	-0.194	-0.144
Beta	0.670	0.684	0.967	0.886

The real average portfolio returns are negative, and therefore the average returns, in excess of the risk-free rate are also negative. An analysis of small size versus big stocks in terms of the maximum average return show that the maximum returns in portfolios with small stocks outperform maximum returns in portfolios with big stocks. The beta measures the volatility of the portfolios in relation to the market portfolio. Portfolios of small stocks have lower beta

values, while big stocks have betas close to 1, a confirmation that the market portfolio consists of big stocks in this study.

For a simplified overview of the average monthly return in percentage in excess of the three-months Kenyan T-bill rate (R_f) for the 12 value-weighted portfolios formed on independent sorts of Size-B/M, Size-OP and Size-INV using 2x2 sorting approach, a summary is shown in Table 5.

Table 5: *Summary of the average monthly excess return in percentage for the portfolios formed on Size-B/M, Size-OP and Size-INV*

Panel A: Size-B/M		**Value**	
		Low	**High**
Size	**Small**	-1.005	-0.541
	Big	-0.554	-1.361
Panel B: Size-Op		**Operating profitability**	
		Weak	**Robust**
Sive	**Small**	-0.419	-1.337
	Big	-0.984	-0.814
Panel C: Size-INV		**Investment**	
		Aggressive	**Conservative**
Size	**Small**	-1.102	-0.406
	Big	-0.976	-0.685

Panel A shows the average returns for 4 portfolios independently sorted on Size and B/M. The value effect is seen in this panel where small size stocks with high B/M value have an average return of -0.541%. As the size of stocks increases, the average return decreases further to -1.361%. The small stock with low B/M value has an average return of -1.005%, and as the size increases, the average return also improves to -0.554%. In low B/M value, the big size growth stocks perform better than small size growth stocks, which indicates no relationship between size and average return when the B/M value is low.

However, the value effect is known to be stronger in small stocks and not in big stocks. As seen in Panel A of Table 5. Big size stock with high B/M have a lower average return compared to big stocks with low B/M value, ignoring the value effect in big stocks.

Panel B shows the average excess returns for 4 portfolios independently sorted on Size and OP. In Panel B, small stocks with weak profitability have higher average returns of -0.419%

compared to portfolios of small stocks with robust profitability which have an average return of -1.337%. There is no clear relationship between small size and average return, or profitability and average return as expected.

Panel C shows the average returns for 4 portfolios independently sorted on Size and INV. Conservative small stocks have an average return of -0.406% while small stocks that invest aggressively have -1.102%. Conservative big stocks have an average return of -0.685% while aggressive big stocks have -0.976%. There is a relationship between investment and average return where firms that invest aggressively have lower average returns. As for the relationship between size and average returns, the expected relationship of small stocks performing better than big stocks is evident in conservative stocks but not in firms that invest aggressively

5.2 Right-Hand-Side factors

These are the five factors which are the explanatory variables in the model. They are constructed using the 12 portfolios as illustrated in Table 4 above.

Table 6: *Summary statistics for the Fama-French 5 factors*

	Mean	Stdev	Max	Min	Skewness	Kurtosis
Rft	0.116	0.263	1.057	-0.703	-0.101	5.527
Rm	-0.777	4.550	11.161	-13.629	-0.515	3.369
Rm-Rf	-0.893	4.549	11.014	-13.768	-0.498	3.366
SMB	0.094	4.124	10.264	-9.384	0.161	2.895
HML	0.185	4.167	9.980	-9.727	0.105	2.811
RMW	0.021	4.363	12.879	-9.412	0.233	2.954
CMA	0.077	4.130	12.394	-9.881	0.280	3.220

As seen in Table 6, the four factors, SMB, HML, RMW, and CMA, have average returns ranging from 0.021% to 0.185%. The market portfolio, in excess of R_f, has an average return of -0.893%. The negative market risk premium is not a surprise since the average risk-free rate is 0.116% while the average market portfolio return is -0.777%.

Even though the average return is weak for each factor, there is still an indication of size, value, profitability, and investment effects as indicated by average returns on the SMB, HML, RMW and CMA factors in column 1 of Table 6. Stocks with small market capitalization outperform those with big market capitalization, hence a confirmation of the size effect. Stocks with high B/M value outperform those with low B/M value. Stocks with robust profit outperform those

with weak profits. Stocks that invest conservatively outperform aggressive investing stocks, confirming the investment effect suggested by Fama and French (2015).

5.3 Factor Performance

Table 7 summarizes the valuation of SMB, HML, RMW, and CMA factors using Sharpe ratio, Treynor's performance index, the Jensen's alpha, and beta in relation to the market portfolio.

Sharpe ratio measures the expected excess return per unit of risk. Portfolios consisting of small and big stocks in table 6 have negative Sharpe ratios. The factors constructed based on these portfolios have positive Sharpe ratios. HML factor has the highest Sharpe ratio at 0.044% while RMW has the least at 0.005%. The betas indicate that the size, value, profitability, and investment factors are moving on the opposite direction from the market portfolio.

Treynor's performance index measures the expected excess return per unit of systematic risk. Jensen's alpha measures expected return above that which is promised by CAPM. The negative results of the Treynor's performance index and Jensen's alpha are a result of the negative betas and market risk premiums, an indication of poor performance of the market portfolio.

Table 7: *A valuation of the four factors*

	Sharpe ratio	Beta	Treynor's performance index	Jensen's alpha
SMB	0.023	-0.277	-0.340	-0.121
HML	0.044	-0.291	-0.634	-0.041
RMW	0.005	-0.290	-0.072	-0.204
CMA	0.019	-0.250	-0.307	-0.117

5.4 Multicollinearity problem

The biggest problem with the four factors constructed using NSE stock market sample data is the strong positive correlation between different factors, also known as multicollinearity. Due to multicollinearity, small changes in the data can lead to unreliable coefficients. To detected multicollinearity among the five factors, a correlation matrix between the five variables is conducted. The rule of thumb is, if the correlation between two explanatory variables is greater than 0.8, multicollinearity exists. A more reliable tool of detecting multicollinearity is the Variance Inflation Factor test (VIF). VIF test quantifies the degree of correlation between the variables. Using the VIF test, a value of 10 and above indicates multicollinearity. Table 8 shows the correlation matrix and the VIF test results of the five factors.

Table 8: *The correlation matrix and results from the VIF test for five factors*

	Rm-Rf	SMB	HML	RMW	CMA
Rm-Rf	1.0000				
SMB	-0.3026	1.0000			
HML	-0.3136	0.9717	1.0000		
RMW	-0.3004	0.9752	0.9093	1.0000	0.9475
CMA	-0.2727	0.9850	0.9414	0.9475	1.0000
VIF test results	0.0000	4E+15	1E+15	4E+14	4E+14

The VIF test shows extremely high positive values for SMB, HML, RMW, and CMA factors. These results indicate perfect positive correlations for SMB, HML, RMW, and CMW. There is a negative correlation between Rm-Rf and each of the factors, an indication of the factors moving on the opposite direction from the market portfolio.

Table 9 shows the correlation matrix between factors in the Fama-French 3-factor model (RM-Rf, SMB, HML). The VIF test results are still high as that of the five factors and not acceptable for OLS.

Table 9*: The correlation matrix and results from the VIF test for three factors*

	Rm-Rf	HML	RMW
Rm-Rf	1.0000		
SMB	-0.3026	1.0000	
HML	-0.3136	0.9717	1.0000
VIF test results	1.1092	17.9412	18.0766

A possible remedy to multicollinearity is dropping one of the collinear variables or increasing the sample size. In this study, all companies listed on the NSE between 2008 to 2018 with available data have been used to test the model. There are no more companies to add to increase the sample size. To solve the multicollinearity problem in this case, SMB and CMA factors are dropped from the model. This action improves the VIF test results to a figure less than 10 as seen in Table 10.

Table 10*: The correlation matrix and results from the VIF test for three factors*

	Rm-Rf	HML	RMW
Rm-Rf	1.0000		
HML	-0.3136	1.0000	
RMW	-0.3004	0.9093	1.0000
VIF test results	1.1107	5.8341	5.7818

With strong evidence of the SMB factor and CMA factors in explaining excess stock returns, dropping these two factors could leads to a possible omitted variables problem (Roberts & Whited, 2013)

5.5 Regression results

To get insights into the model performance, the next step is examining the intercept and slopes of the models estimated by OLS after conducting diagnostic and specification testing. The assumption is that the intercept α_i for all portfolios should be zero if the exposures to the factors capture all variations in expected excess stock returns. The second assumption is that adding SMB, HML, RMW, and CMW factors to CAPM improves the model by capturing all variations in expected excess stock returns.

For each of the 12 dependent portfolios, regression analysis has been conducted following CAPM and the Fama-French 3-factor model using Rm-Rf, HML and RMW factors after eliminating SMB and CMA factors from the Fama-French 5-factor model.

Model 1: CAPM

$$R_i - R_f = \alpha + \beta i,m(R_m - R_f)$$

Model 2: Fama-French 3-factor model

$$R_i - R_f = \alpha + \beta i,m(R_m - R_f) + hiHML + ciRMW$$

5.5.1 4 Size-B/M portfolios

Table 11 summarizes the intercepts and slopes with its related p-values and the adjusted R^2 for the 4 Size-B/M portfolios, which are SH, SL, BH, and BL.

Table 11*: Regression results for 4 value-weight Size-B/M portfolios*

CAPM

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + e_t$$

Size-B/M		**Low**	**High**	**Low**	**High**
		α		**p-values**	
Intercept	Small	-0.396	0.060	0.3620	0.8765
	Big	0.240	-0.432	0.2355	0.0936
		β			
Market	Small	0.682	0.673	0.0000	0.0000
	Big	0.889	1.040	0.0000	0.0000
		R^2			
	Small	0.30	0.35		
	Big	0.78	0.75		

Fama-French 3-factor model

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + hHML_t + cRMW_t + e_t$$

Size-B/M		**Low**	**High**	**Low**	**High**
		α		**p-values**	
Intercept	Small	-0.444	0.234	0.0791	0.2883
	Big	0.175	-0.398	0.3656	0.0830
		β			
Market	Small	0.932	0.912	0.0000	0.0000
	Big	0.864	0.958	0.0000	0.0000
		h			
Value	Small	1.549	0.136	0.0000	0.2759
	Big	0.271	-0.858	0.0148	0.0000
		c			
Profitability	Small	-0.677	0.696	0.0000	0.0000
	Big	-0.357	0.667	0.0008	0.0000
		R^2			
	Small	0.77	0.79		
	Big	0.80	0.80		

At a 5% significance level, the intercepts are not significantly different from zero both for CAPM and for the 3-factor model. The adjusted R^2 is between 30% and 78% for CAPM, and between 77% and 80% for Fama-French 3-factor model.

For the 3-factor model, the HML coefficient for small stocks with low B/M is strongly positive, while weakly positive for high B/M and not significantly different from zero. Big stocks with low B/M have a positive coefficient and negative for big stocks with high B/M. The model fails to show that average returns increase with increase in B/M. On the contrary, small stocks with low B/M, growth stocks, strongly positive and significantly influence variations in stock returns.

Small and big size stocks in the low profitability group have negative RMW coefficients, while positive coefficients for high profitability group regardless of stock size. The RMW coefficients are significant.

5.5.2 4 Size-OP portfolios.

Table 12 summarizes the intercepts and slopes with its related p-values and the adjusted R^2 for the 4 Size-OP portfolios, which are SR, SW, BR, and BW.

At a 5% significance level, the intercepts are not significantly different from zero both for CAPM and for the 3-factor model. The adjusted R^2 is between 24% and 76% for CAPM and improves to between 75% and 79% for Fama-French 3-factor model

In the 3-factor model, the coefficients other than the market which have explanatory power, the HML coefficients are significant and negative as the profitability increases. The RMW coefficients are negative for the weak profitability stocks regardless of the size and positive for robust profitability stocks.

Furthermore, the small size stocks with robust profit have a higher coefficient than big size with robust profit. There is no clear pattern for any of the coefficients

Table 12: *Regression results for 4 value-weight Size-OP portfolios*

CAPM

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + e_t$$

Size-OP		Low	High	Low	High
		α		**p-values**	
Intercept	Small	0.205	-0.773	0.5720	0.1043
	Big	-0.105	0.009	0.7130	0.9664
		β			
Market	Small	0.699	0.632	0.0000	0.0000
	Big	0.985	0.922	0.0000	0.0000
		R^2			
	Small	0.40	0.24		
	Big	0.68	0.76		

Fama-French 3-factor model

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + hHML_t + cRMW_t + e_t$$

Size-OP		Low	High	Low	High
		α		**p-values**	
Intercept	Small	0.254	-0.466	0.2380	0.0660
	Big	-0.241	0.029	0.3453	0.8936
		β			
Market	Small	0.926	0.901	0.0000	0.0000
	Big	0.944	0.883	0.0000	0.0000
		h			
Value	Small	0.842	-0.526	0.0000	0.0003
	Big	0.625	-0.310	0.0000	0.0120
		c			
Profitability	Small	-0.050	1.461	0.6650	0.0000
	Big	-0.766	0.176	0.0000	0.1294
		R^2			
	Small	0.79	0.79		
	Big	0.75	0.77		

5.5.3 4 Size-INV portfolios

Table 13 summarizes the intercepts and slopes with its related p-values and the adjusted R^2 for the 4 Size-INV portfolios, which are SC, SA, BC, and BA.

Table 13: *Regression results for 4 value-weight Size-INV portfolios*

CAPM

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + e_t$$

Size-INV					
		Low	**High**	**Low**	**High**
		α		**p-values**	
Intercept	Small	0.204	-0.502	0.6433	0.2073
	Big	0.106	-0.116	0.6537	0.6174
		β			
Market	Small	0.683	0.672	0.0000	0.0000
	Big	0.886	0.963	0.0000	0.0000
		R^2			
	Small	0.30	0.34		
	Big	0.72	0.76		

Fama-French 3-factor

$$R_t - R_{Ft} = \alpha + \beta(Rm_t - RF_t) + hHML_t + cRMW_t + e_t$$

Size-INV					
		Low	**High**	**Low**	**High**
		α		**p-values**	
Intercept	Small	0.309	-0.371	0.2596	0.1998
	Big	0.055	-0.133	0.8135	0.5537
		β			
Market	Small	0.954	0.885	0.0000	0.0000
	Big	0.869	0.908	0.0000	0.0000
		h			
Value	Small	0.717	0.264	0.0000	0.1088
	Big	0.224	-0.173	0.0947	0.17682
		c			
Profitability	Small	0.227	0.475	0.1266	0.0028
	Big	-0.285	-0.018	0.0264	0.8797
		R^2			
	Small	0.73	0.65		
	Big	0.72	0.77		

At a 5% significance level, the intercepts are not significantly different from zero both for CAPM and for the 3-factor model. The adjusted R^2 is between 30% and 76% for CAPM and improves to between 65% and 77% for Fama-French 3-factor model.

The coefficients for the market factor are strongly positive, while statistically and significantly different from zero. The coefficients seem to increase with size for aggressive stocks and decrease with size for conservative stocks in terms of investing.

Coefficients of the HML factors are not significant at a 10% significance level except for the small and conservative stocks, which are also strongly positive.

The RMW coefficients are positive for small stocks and negative for big stocks. Furthermore, the p-values show that at a 1% significance level, small stocks of firms which invest aggressively have a significant coefficient. There is a relationship between size of stocks and investment whereby small stocks have positive coefficients and negative for big stocks.

At a 5% significance level, one HML and two RMW factor loadings are significant, but with no consistent relationship to aggressive or conservative investment and size of stocks.

6 Summary of findings and limitations

The intercepts for all the 12 portfolios in CAPM are not significant at a 5% significance level. Similarly, the intercepts for the 12 portfolios in the 3-factor model are not significantly different from zero. The model neither overestimates nor underestimates the portfolio returns. In CAPM, all the coefficients of the market risk factor are significantly different from zero for all 12 portfolios. The coefficients of HML and RMW factors are not significant for all portfolios.

When comparing the adjusted R^2 of the two models, the 3-factor model improves CAPM. The improvement is seen in small size stocks and not for the big stocks where the market risk coefficients are strongly positive and close to one for big stocks but not for small stocks.

For the 3-factor model, all market risk coefficients are strongly positive and close to one, making the market risk coefficients not of much help in describing the stock return variations. Due to a small stock market, the big stocks in this study consist of all the NSE 20 share index, the market portfolio used in the model.

Most stocks included in this study suffer from smaller trading volumes leading to mispricing because of non-trading. Non-trading occurs when some stocks are traded less frequently than

others, and this is a major problem of the NSE. Low trading volumes affects almost all the stocks traded in NSE.

The volatility of risk-free T-bill rate, the proxy for the risk-free interest rate used in this study, makes the interest rate not a risk-free asset to use in the Fama-French 5-factor model. Between 2008 and 2019, which is the period under study, the 91-Day T-bill rate varied between 1.5% and 22%, before adjusting for inflation.

A monthly inflation rate has been used to convert nominal rates to real rates. The monthly inflation rates are very volatile, creating an additional source of uncertainty for investors in the Kenyan stock market (Figure 1). Inflation continues to contribute largely in wiping out any stock return on the NSE. Inflation in 2018 stood at 4.69% but increased to 5.2% in 2019 (Central Bank of Kenya, 2020).

The low amount of data used in this study compared to Fama-French 5-factor model is a major drawback to this study. A total 93 equities have been listed in the Nairobi Securities Exchange between 1991 to date according to data obtained from DataStream and Bloomberg. 58 out of the 93 stocks are included in this analysis. This is because the stocks not included are either delisted or suspended for a prolonged period and eventually expelled from trading at the NSE. The 58 stocks out of 93 are the only ones with reliable accounting and stock price data needed in this study. 65% of stocks ever listed on the NSE, active or no longer active, went public between 1991 and 1999, and 30% went public between the year 2000 to date. No new listings have occurred since 2018.

More than 50% of the stocks listed in NSE are financial institutions (banks, financial services, and insurance companies). 50% of these companies went public on the NSE in 1991. Stocks with the highest trading volume started trading in 2008 even though the Nairobi Securities Exchange has been in operation since 1954.

7 Conclusion

This study tests the CAPM and the Fama-French 5 factor model. Due to insufficient data, two factors, SMB and CMA have been dropped from the Fama-French 5-factor model. The remaining three factors used in the model yielded inconclusive results.

The intercepts of the CAPM model are zero and the market risk coefficient are non-zero with significant explanatory power especially for small stocks. A comparison of the model performances show that the Fama-French three-factor model improves CAPM in explaining the excess stock returns but mainly for small stocks. More data is needed to test the model further by including all five factors.

The main limitation in this study, i.e. the sample size, directly affect the model performance, but the existence of factor premiums in the NSE is not rejected. It is difficult to implement an asset pricing model to an underdeveloped, illiquid, and small stock market like the NSE and obtain significant results as those of developed stock markets.

It is important to note that in asset pricing models, multifactor models tend to be country-specific rather than having an application with a global reach. The significance of the additional factors to CAPM respond differently to different data sets.

There is a possibility of factor premiums to exist on the NSE by taking a long position on small size stocks with high B/M value and robust profitability, and a short position on big size stocks with low B/M value. More data, not currently possible to obtain, is needed to test this possibility on the NSE. Current changes on the NSE, including an introduction of modern equity trading systems that enable day trading and short selling, will boost the liquidity and trading volumes of the NSE.

Transaction costs that an investor can encounter when trading equities on the NSE are not considered in this study. Future research of factor premiums on the NSE should consider transaction costs to obtain a full picture of these costs on the already negative risk premiums.

Illiquidity is a major problem on the NSE as it is with many small and developing equity markets. But not all traded stocks on the NSE face the illiquidity problem. Future studies should look into the illiquidity factor in the model as having the possibility to improve the model performance.

REFERENCE

Banz, R., W. (1981). The Relationship Between Return and Market Value of Common Stocks, *Journal of Financial Economics*, *Elsevier*, vol. 9, no. 1, pp. 3-18

Basu, S. (1977). Investment Performance of Common Stocks in Relation to their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis, *The Journal of Finance*, vol. 32, no. 3, pp. 663–682. Available online: https://doi.org/10.1111/j.1540-6261.1977. tb01979.x [Accessed 17 May 2020]

Black, F. (1972). Capital Market Equilibrium with Restricted Borrowing, *The Journal of Business*, vol. 45, no. 3, pp. 444–455, Available online: https:// doi.org/10.1086/295472 [Accessed 1 May 2020]

Central Bank of Kenya. (2020). Available online: https://www.centralbank.go.ke/bills-bonds/treasury-bills/#91_day_results [Accessed 22 April 2020]

Chen, X, Song, P., Gao, K. and Qiao, Y. (2017) The Application in the Portfolio of China's A-share Market with Fama-French 5-factor Model and the Robust Median Covariance Matrix, *International Journal of Economics, Finance and Management Sciences*, vol. 5, no. 4,.pp. 222-228

Chial, M., Chai, D., Zhong, A. and Li, S. (2016). Better Model an Empirical Investigation of the Fama–French 5-factor Model in Australia, *International Review of Finance*, vol.16, no. 4, pp. 595–638

CIA. (2020). The World Factbook, Kenya, Available online: https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html [Accessed 15 May 2020]

Cox, S., & Britten, J. (2019). The Fama-French 5-factor model: Evidence from the Johannesburg Stock Exchange, *Investment Analysts Journal*, vol. 48, no. 3, pp. 240-261, Available online: https://doi.org/10.1080/10293523.2019.1647982 [Accessed 30 April 2020]

Dirkx, P., & Peter, F. (2018). Implementing the Fama-French 5-factor Model for the German Stock Market, *SSRN Electronic Journal*, Available online: http://dx.doi.org/10.2139/ssrn.3300642 [Accessed 20 May 2020]

Elfakhani, S., & Wei, J. (2003). The survivorship bias, share price effect, and small firm effect in Canadian markets, *Review of Financial Economics*, vol. 12, no. 4, pp. 397-411, Available online: https://doi-org.ludwig.lub.lu.se/10.1016/j.rfe.2003.09.002 [Accessed 28 April 2020]

Eugene F. Fama, E. F., & Kenneth R. French, K. R. (1993). Common Risk Factors in the Returns on Stocks and Bonds, *Journal of Financial Economics*, vol.33, no.1, pp. 3-56

Fama, E. F., & French, K. R. (2015). A 5-factor asset pricing model, *Journal of Financial Economics*, vol. 116, no. 1, pp. 1–22, Available online: https://doi.org/10.1016/j.jfineco.2014.10.010 [Accessed 16 March 2020]

Fama, E. F., & French, K. R. (2017). International tests of a 5-factor asset pricing model, *Journal of Financial Economics*, vol.123, no. 3, pp. 441–463, Available online: https://doi.org/10.1016/j.jfineco.2016.11.004 [Accessed 16 March 2020]

Guo, B., Zhangb, W., Zhangb, Y. & Zhange, H. (2017). The 5-factor Asset Pricing Model Tests for the Chinese Stock Market, *Pacific-Basin Finance Journal*, vol. 43, pp. 84-106

Haugen, R, A. & Heins, A. J (1972). On the Evidence Supporting the Existence of Risk Premiums in the Capital Market, *SSRN Electronic Journal,* Available online: http://dx.doi.org/10.2139/ssrn.1783797 [Accessed 1 May 2020]

Huynh, T. D. (2017) Explaining Anomalies in Australia with a 5-factor Asset Pricing Model, *International Review of Finance*, pp. 1-13, Available online: https://doi.org/10.1111/irfi.12125 [Accessed 1 May 2020]

International Monetary Fund (2020). Country Data, Kenya. Available online: https://www.imf.org/en/Countries/KEN#ataglance [Accessed 21 May 2020]

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency, *Journal of Finance*, vol. 48, no. 1, pp. 65-91

Lintner, J. (1965). The Valuation of Risk Assets and The Selection of Risky Investments in Stock Portfolios and Capital Budgets, *The Review of Economics and Statistics*, vol. 47, no. 1, pp. 13–37. Available online: https://doi.org/10.2307/1924119 [Accessed 1 May 2020]

Mosoeu, M., & Kodongo, O. (2019). The Fama-French 5-factor Asset Pricing Model and Emerging Markets Equity Returns , Available online: http://dx.doi.org/10.2139/ssrn.3377918 [Accessed 1 May 2020]

Mossin, J. (1966). Equilibrium in a Capital Asset Market, *Econometrica*, vol. 34, no. 4, pp. 768–783. Available online: https://doi.org/10.2307/ 1910098 [Accessed 1 May 2020]

Nairobi Securities Exchange (2020). Companies listed. Available online: https://www.nse.co.ke/market-statistics/equity-statistics.html?view=statistics [Accessed 1 May 2020]

Novy-Marx, R. (2013). The Other Side of Value: The Gross Profitability Premium, *Journal of Financial Economics*, vol. 108, no. 1, pp. 1–28, Available Online: 10.1016/j.jfineco.2013.01.003 [Accessed 1 May 2020]

Poole, R.W. (1996). Privatization for Economic Development, *The Privatization Process. Edition, Terry L. Anderson and Peter J. Hill*, United States of America: Rowman & Littlefield Publishers, Inc., pp. 1-18

Roberts, M. R. & Whited, T. M. (2013). Endogeneity in Empirical Corporate Finance, *Handbook of the Economics of Finance*, in: vol. 2, pp.493-572, Available online: 0.1016/B978-0-44-453594-8.00007-0 [Accessed 22 May 2020]

Ross, S. A. (1976). Arbitrage Theory of Capital Asset Pricing, *Journal of Economic Theory*. Vol.13, no. 3, pp. 341–60, Available online: https://doi.org/10.1016/0022-0531(76)90046-6 [Accessed 16 April1 2020]

Sharpe, W., F. (1964). Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk, *Journal of Finance,* vol.19, no. 3, pp. 425–442, Available online: https://www.jstor.org/stable/2977928?origin=JSTOR-pdf&seq=1 [Accessed May 1, 2020]

Tarhan, V. (2005). General Characteristics of Developing Country Capital Markets and Asymmetry Related Allocation Problems, The Journal of Economic Asymmetries vol. 2, pp 59-80, Available online: 10.1016/j.jeca.2005.01.004.

Titman, S., Wei, K., & Xie, F. (2004). Capital Investment and Stock Returns, *Journal of Financial and Quantitative Analysis*, vol. 39, pp.677-700

Treynor, J. (1961). Market value, time, and risk, Available online: https://ssrn.com/abstract=2600356 [Accessed 30 April 2020]

Treynor, J. (1962). Toward a theory of market value of risky assets, Available online: http://dx.doi.org/10.2139/ssrn.628187 [Accessed 30 April 2020]

World Bank (2018). Kenya Economic Update, Available online: http://documents.worldbank.org/curated/en/766271538749794576/pdf/Kenya-Economic-Update-18-FINAL.pdf [Accessed 18 May 2020]

Zaher, F. (2019). Index Fund Management: A Practical Guide to Smart Beta, Factor Investing and Risk Premia, London: Palgrave Macmillan

Zeren, F., Yilmaz, T., & Belke, M. (2019) Testing the Validity tf Fama French Five Factor Asset Pricing Model: Evidence From Turkey, *The 22nd Finance Symposium on 10-13 October 2018, Yanışlı, Mersin, Turkey*

Zhang, Y., Li, F. & Gong, Y. (2018), Research on the Applicability of Fama-French Five factor Model in Chinese A-share Market, Available online: https://doi.org/10.2991/iccese-18.2018.204

APPENDIX

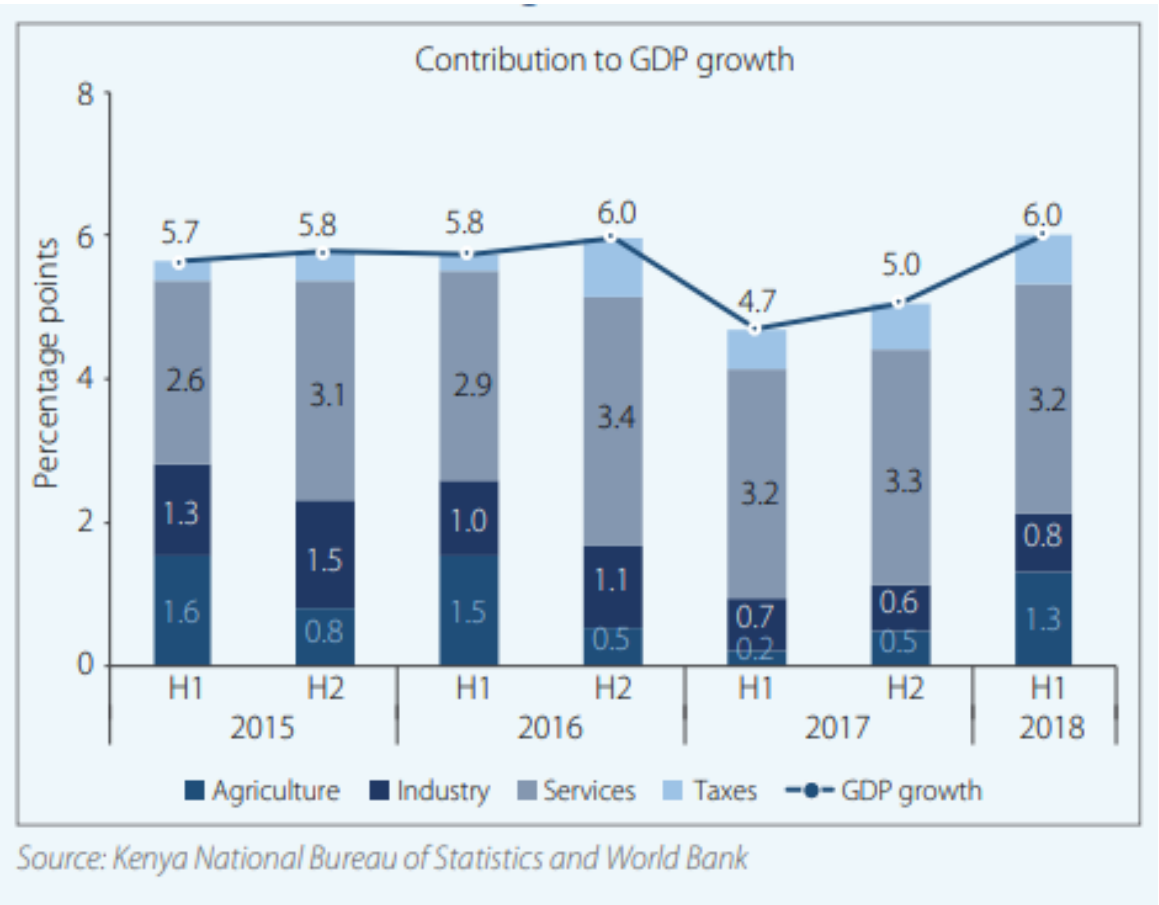

Figure A.1. Contribution to the Kenyan GDP by Sector

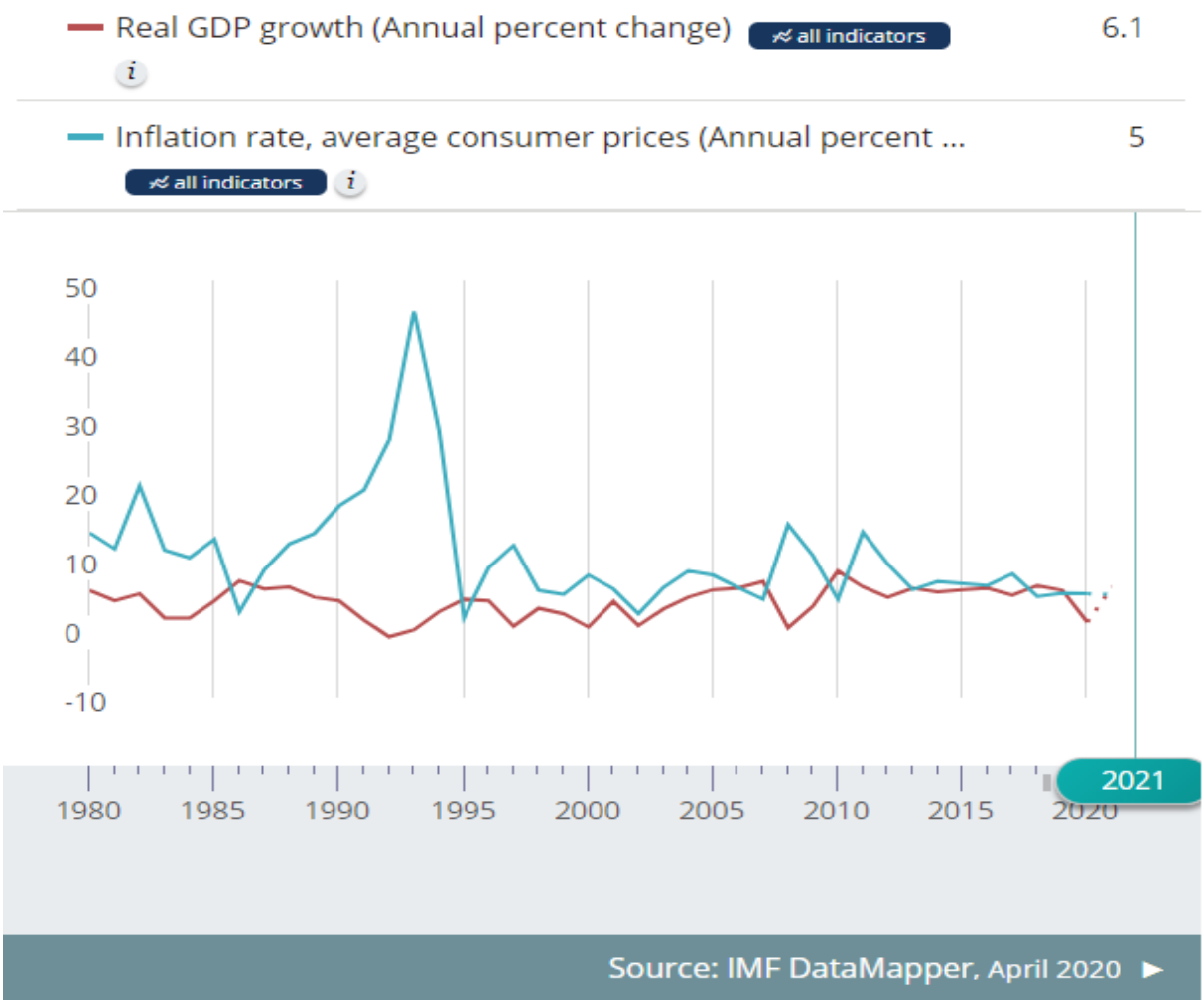

Figure A.2. The real GDP growth for Kenya from 1980 to 2020

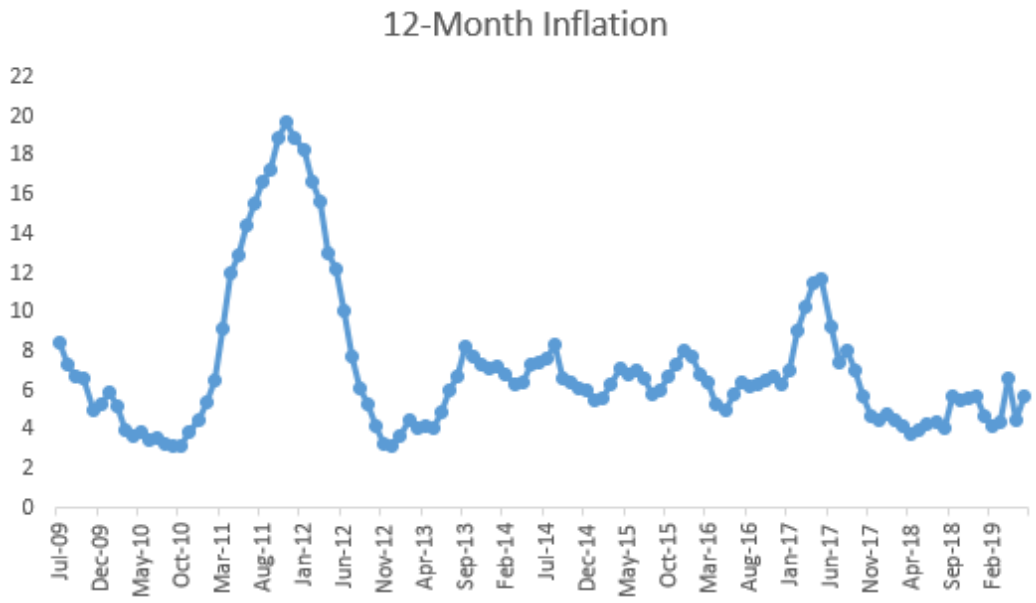

Figure A.3. Monthly consumer prices inflation for Kenya between July 2009 to June 2019

Source: Central Bank of Kenya

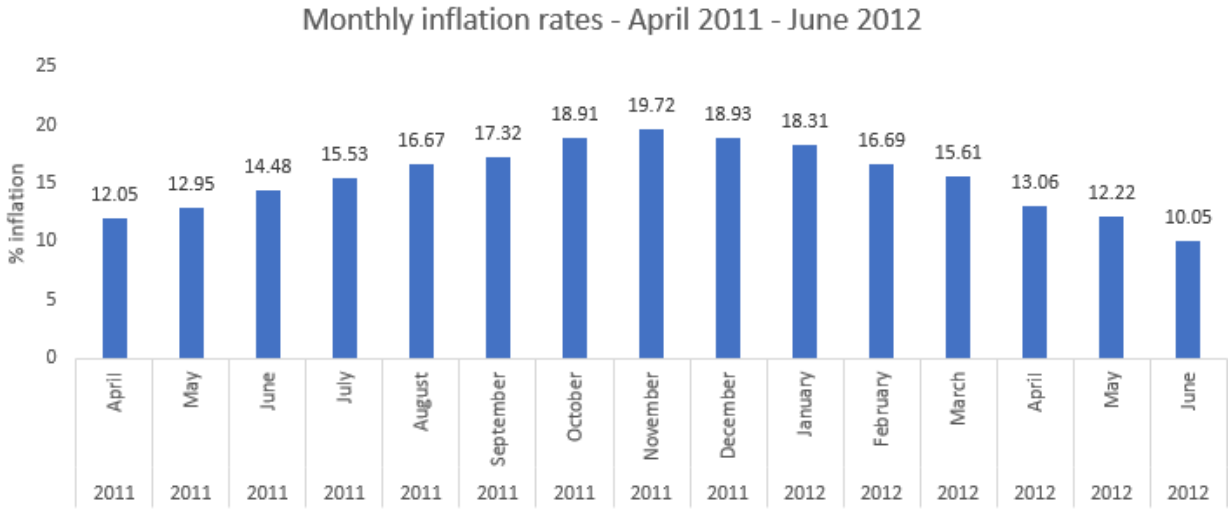

Figure A.4. Monthly consumer prices inflation between April 2011 to June 2012

Source: Central Bank of Kenya

Table A.1. Listed companies on the Nairobi Securities Exchange as of April 2020

FEATURES OF NSE EQUITY SECURITIES			
SECURITIES	**ISIN CODE**	**TRADING SYMBOL**	**NUMBER OF ISSUED SHARES**
AGRICULTURAL			
Eaagads Ltd Ord 1.25 AIM	KE0000000208	EGAD	32,157,000
Kakuzi Plc Ord.5.00	KE0000000281	KUKZ	19,599,999
Kapchorua Tea Co. Ltd Ord Ord 5.00 AIM	KE4000001760	KAPC	7,824,000
The Limuru Tea Co. Plc Ord 20.00AIMS	KE0000000356	LIMT	2,400,000
Sasini Plc Ord 1.00	KE0000000430	SASN	228,055,500
Williamson Tea Kenya Ltd Ord 5.00 AIM	KE0000000505	WTK	17,512,640
AUTOMOBILES & ACCESSORIES			
Car & General (K) Ltd Ord 5.00	KE0000000109	CGEN	40,103,308
BANKING			
ABSA Bank Kenya Plc Ord 0.50	KE0000000067	ABSA	5,431,536,000
BK Group Plc Ord 0.80	KE5000008986	BKG	896,759,222
Diamond Trust Bank Kenya Ltd Ord 4.00	KE0000000158	DTK	279,602,220
Equity Group Holdings Plc Ord 0.50	KE0000000554	EQTY	3,773,674,802
HF Group Plc Ord 5.00	KE0000000240	HFCK	384,614,168
I&M Holdings Plc Ord 1.00	KE0000000125	IMH	826,810,738
KCB Group Plc Ord 1.00	KE0000000315	KCB	3,209,043,204
National Bank of Kenya Ltd Ord 5.00	KE0000000398	NBK	41,669,967
NIC Group Plc Ord 5.00	KE0000000406	NCBA	1,497,745,028
Stanbic Holdings Plc ord.5.00	KE0000000091	SBIC	395,321,638
Standard Chartered Bank Kenya Ltd Ord 5.00	KE0000000448	SCBK	343,510,572
The Co-operative Bank of Kenya Ltd Ord 1.00	KE1000001568	COOP	5,867,175,695

COMMERCIAL AND SERVICES			
Deacons (East Africa) Plc Ord 2.50AIMS	KE5000005438	DCON	123,558,228
Eveready East Africa Ltd Ord.1.00	KE0000000588	EVRD	210,000,000
Express Kenya Ltd Ord 5.00 AIMS	KE0000000224	XPRS	47,711,481
Kenya Airways Ltd Ord 5.00	KE0000000307	KQ	5,681,693,215
Longhorn Publishers Plc Ord 1.00AIMS	KE2000002275	LKL	272,440,473
Nairobi Business Ventures Ltd Ord. 1.00 GEMS	KE5000000090	NBV	38,600,000
Nation Media Group Ltd Ord. 2.50	KE0000000380	NMG	188,542,286
Sameer Africa Plc Ord 5.00	KE0000000232	SMER	278,342,393
Standard Group Plc Ord 5.00	KE0000000455	SGL	81,731,808
TPS Eastern Africa Ltd Ord 1.00	KE0000000539	TPSE	182,174,108
Uchumi Supermarket Plc Ord 5.00	KE0000000489	UCHM	364,959,616
WPP Scangroup Plc Ord 1.00	KE0000000562	SCAN	432,155,985
CONSTRUCTION & ALLIED			
ARM Cement Plc Ord 1.00	KE0000000034	ARM	959,940,200
Bamburi Cement Ltd Ord 5.00	KE0000000059	BAMB	362,959,275
Crown Paints Kenya Plc Ord 5.00	KE0000000141	CRWN	71,181,000
E.A.Cables Ltd Ord 0.50	KE0000000174	CABL	253,125,000
E.A.Portland Cement Co. Ltd Ord 5.00	KE0000000190	PORT	90,000,000
ENERGY & PETROLEUM			
KenGen Co. Plc Ord. 2.50	KE0000000547	KEGN	6,594,522,339
Kenya Power & Lighting Co Ltd Ord 2.50	KE0000000349	KPLC	1,951,467,045
Kenya Power & Lighting Co Ltd 4%	KE4000001877	KPLC.P0004	
Kenya Power & Lighting Co Ltd 7%	KE4000002982	KPLC.P0007	
Total Kenya Ltd Ord 5.00	KE0000000463	TOTL	175,065,000
Umeme Ltd Ord 0.50	KE2000005815	UMME	1,623,878,005
INSURANCE			
Britam Holdings Plc Ord 0.10	KE2000002192	BRIT	2,523,486,816
CIC Insurance Group Ltd ord.1.00	KE2000002317	CIC	2,615,538,528
Jubilee Holdings Ltd Ord 5.00	KE0000000273	JUB	72,472,950
Kenya Re Insurance Corporation Ltd Ord 2.50	KE0000000604	KNRE	2,799,796,272
Liberty Kenya Holdings Ltd Ord.1.00	KE2000002168	LBTY	535,707,499
Sanlam Kenya Plc Ord 5.00	KE0000000414	SLAM	144,000,000
INVESTMENT			
Centum Investment Co Plc Ord 0.50	KE0000000265	CTUM	665,441,714
Home Afrika Ltd Ord 1.00	KE2000007258	HAFR	405,255,320
Kurwitu Ventures Ltd Ord 100.00	KE4000001216	KURV	102,272
Olympia Capital Holdings ltd Ord 5.00	KE0000000166	OCH	40,000,000
Trans-Century Plc Ord 0.50AIMS	KE2000002184	TCL	375,202,766
INVESTMENT SERVICES			
Nairobi Securities Exchange Plc Ord 4.00	KE3000009674	NSE	259,500,791

MANUFACTURING & ALLIED			
B.O.C Kenya Plc Ord 5.00	KE0000000042	BOC	19,525,446
British American Tobacco Kenya Plc Ord 10.00	KE0000000075	BAT	100,000,000
Carbacid Investments Ltd Ord 1.00	KE0000000117	CARB	254,851,985
East African Breweries Ltd Ord 2.00	KE0000000216	EABL	790,774,356
Flame Tree Group Holdings Ltd Ord 0.825	KE4000001323	FTGH	178,053,486
Kenya Orchards Ltd Ord 5.00 AIM	KE0000000331	ORCH	12,868,124
Mumias Sugar Co. Ltd Ord 2.00	KE0000000372	MSC	1,530,000,000
Unga Group Ltd Ord 5.00	KE0000000497	UNGA	75,708,873
TELECOMMUNICATION			
Safaricom Plc Ord 0.05	KE1000001402	SCOM	40,065,428,000
REAL ESTATE INVESTMENT TRUST			
STANLIB FAHARI I-REIT	KE5000003656	FAHR	180,972,300
EXCHANGE TRADED FUNDS			
NEW GOLD ETF	KE5000007095	GLD	150,000

Source: Nairobi Securities Exchange

Table A.2. Summary statistics for the factor components in

	SH	SL	SR	SW	SC	SA	BH	BL	BR	BW	BC	BA
Mean	0.05	-0.41	-0.75	0.17	0.19	-0.51	-0.77	0.04	-0.22	-0.40	-0.09	-0.39
Stdev	5.13	5.60	5.84	5.02	5.64	5.25	5.46	4.58	4.81	5.40	4.76	5.03
Max	24.17	17.12	13.97	21.48	28.18	18.65	15.61	10.54	13.04	11.64	11.82	12.78
Min	-9.29	-15.74	-13.20	-10.75	-11.18	-11.86	-17.51	-14.35	-14.89	-16.38	-13.23	-17.35
Sharpe ratio	0.01	-0.07	-0.13	0.03	0.03	-0.10	-0.14	0.01	-0.05	-0.07	-0.02	-0.08
Beta	0.67	0.68	0.63	0.70	0.68	0.67	1.04	0.89	0.92	0.98	0.88	0.96
Treynor	0.08	-0.61	-1.18	0.25	0.28	-0.76	-0.75	0.04	-0.24	-0.40	-0.11	-0.40
Jensens	0.18	-0.29	-0.63	0.30	0.31	-0.39	-0.58	0.20	-0.05	-0.21	0.07	-0.21
Std error	4.14	4.69	5.11	3.91	4.73	4.29	2.72	2.17	2.36	3.05	2.55	2.47
IR	0.04	-0.06	-0.12	0.08	0.07	-0.09	-0.21	0.09	-0.02	-0.07	0.03	-0.08