SMART BETA APPROACH OF INDEX BASE INVESTING AND THE FACTOR INVESTING PHENOMENON: THE TURKISH CASE

ALİ NEZİH AKYOL

BOĞAZİÇİ UNIVERSITY

2022

SMART BETA APPROACH OF INDEX BASE INVESTING AND THE FACTOR INVESTING PHENOMENON: THE TURKISH CASE

Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Doctor of Philosopy

in

Management

Ali Nezih Akyol

Boğaziçi University

2022

DECLARATION OF ORIGINALITY

I, Ali Nezih Akyol, certify that,

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;
- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
- this is a true copy of the thesis approved by my advisor and thesis committee at Boğaziçi University, including final revisions required by them.

Signature……

Date……

ABSTRACT

Smart Beta Approach of Index Base Investing and the Factor Investing Phenomenon: The Turkish Case

Traditional Capital Asset Pricing Model (CAPM) tests use a cap-weighted equity market portfolio as the market proxy for the CAPM market portfolio. A majority of these tests have found that either the CAPM relationship does not hold (a true failing of the model), or the equity market portfolio is not a good proxy of the CAPM market portfolio. Consequently, these empirical findings directly challenge the mean-variance optimality of the market portfolio. As cap-weighted indexes bear a natural bias towards large-cap and overpriced stocks, they have relatively limited exposure to underpriced (i.e., value) stocks. Many index-based techniques have been introduced in recent years to overcome this bias and unlock the potential for value investing, like smart(alternative) beta index investing and factor investing. This study challenges CAPM's original conviction that a passive investor/manager can do no better than holding a market portfolio in the Turkish equity market context. According to CAPM, generating a positive alpha (abnormal positive return) through an active investment strategy is not possible, and any such achievement should be attributed to the chance factor. We challenge this conviction and use Arnott, Hsu, and Moore's (2005) fundamental indexation (also referred to as smart or alternative) beta indexing) methodology and Ang, Goetzmann, and Schaefer's (2009) Factor Investing approach (adapted from MSCI-Foundations of Factor Investing (2013)) alternatively. Using these alternative methodologies we tested whether a positive

Jensen’s alpha generation is possible through the introduction of these new risk factors. This analysis was limited to the Turkish equity market.

ÖZET

Akıllı Beta yaklaşımıyla endekse dayalı yatırım ve faktör yatırımı olgusu:

Türkiye Örneği

Geleneksel Finansal Varlık Fiyatlama Modeli (FVFM) testleri, FVFM piyasa portföyü yerine piyasa değeri ağırlıklı bir hisse senedi piyasası portföyünü ikame portföy olarak kullanır. Bu testlerin çoğu, FVFM ilişkisinin geçerli olmadığını (modelin başarısız olduğunu) veya hisse senedi piyasası portföyünün, FVFM piyasa portföyünün yerine kullanılamayacağı olgusunu destekleyen sonuçlar ortaya koymuştur. Sonuç olarak, bu ampirik bulgular piyasa portföyünün ortalama-varyans optimalitesinin geçerliliğini de sorgulamaktadır. Piyasa değeri ağırlıklı endeksler, büyük piyasa değerli ve aşırı fiyatlanmış hisse senetlerine karşı doğal bir eğilim barındırdığından, düşük fiyatlanmış (yani değer) hisse senetlerine nispeten sınırlı bir temsil imkanı sunmaktadır. Son yıllarda bu eğilimin etkisini sınırlamak ve değer yatırımı potansiyelini ortaya çıkarmak için akıllı (alternatif) beta endeksi yatırımı ve faktör yatırımı gibi birçok endeks tabanlı teknik ortaya çıkmıştır. Bu çalışma, Türk hisse senedi piyasası bağlamında FVFM'nin pasif bir yatırımcının/varlık yöneticisinin toplam piyasa portföyünü elinde tutmaktan daha iyisini yapamayacağına dair önermesini sorgulamaktadır. FVFM'ye göre, aktif bir yatırım stratejisi yoluyla pozitif bir alfa (anormal pozitif getiri) oluşturmak mümkün değildir ve böyle bir başarı şans faktörüne atfedilmelidir. Bu önermenin geçerliliğini test etmek için Arnott, Hsu ve Moore'un (2005) temel indeksleme metodolojisi (akıllı veya alternatif beta indeksleme olarak da anılmaktadır) ve Ang, Goetzmann, ve Schaefer'in (2009) faktör yatırımı yaklaşımı (MSCI-Faktör yatırımının temelleri

(2013) yönergesinden uyarlanarak) birbirine alternatif test yöntemi olarak kullanılmıştır. Bu çerçevede, söz konusu alternatif metodolojilerin ortaya çıkardığı yeni risk faktörlerinin pozitif Jensen alfası üretme potansiyeli test edilmiştir. Bu çalışma Türk hisse senedi piyasası ile sınırlı tutulmuştur.

CURRICULUM VITAE

NAME: Ali Nezih Akyol

DEGREES AWARDED

Doctor of Philosophy in Management, 2022, Boğaziçi University
Master of Arts in Finance, 1986, Boğaziçi University
Bachelor of Arts in Finance and Accounting, 1983, Boğaziçi University

AREAS OF SPECIAL INTEREST

Capital markets, asset pricing, portfolio management, risk management

PROFESSIONAL EXPERIENCE

Advisor to the Board, SUVLA Şarapları Tarım Sanayi ve Ticaret A.Ş., 2017-Present
General Manager, Bender Portföy Yönetimi A.Ş., Arma Portföy Yönetimi A.Ş., Magna Capital Portföy Yönetimi A.Ş., 2004-2017
General Manager, Meksa Yatırım Menkul Değerler A.Ş., 2000-2002
General Manager, Med Menkul Değerler A.Ş., 1998-2000
General Manager, TAIB Yatırım A.Ş., 1997-1998
Assistant General Manager, TAIB Yatırımbank A.Ş., 1996-1997
Manager-Capital Markets, Türk Ekonomi Bankası A.Ş., 1992-1996
Assistant Manager-Corporate Advisory Services, Türk Ekonomi Bankası A.Ş., 1989-1992
Assistant to the Chief Operating Officer, Altınyıldız Group of Companies, 1987-1989
Technical Member of the Steering Committee, Altınyıldız Group of Companies, 1984-1987
Research Assistant, Boğaziçi University, The Faculty of Business Administration, 1983-1984

PUBLICATIONS

Journal Articles

Akyol, A. N., (2022). Smart Beta Strategies: A New Hype or a Lasting Phenomenon. International Journal of Economics, Commerce and Management, Vol:10, Issue:7, 1-13.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my thesis advisor Prof. Vedat Akgiray for his invaluable assistance and support, as well as his patience and understanding during his mentorship for seven years leading to this thesis. My sincere thanks and gratitude also goes to the members of my thesis defense committee, Assist. Prof. Cenk C. Karahan, Assist. Prof. Erdinç Akyıldırım, Assoc. Prof. Cumhur Ekinci and Assist. Prof. Melik Ertuğrul for their invaluable guidance and insights. On a special note, I must mention Assist. Prof. Cenk C. Karahan's valuable contributions to my work through his timely feedback and ongoing encouragement.

I am grateful to my friends and family for their constant support and motivation throughout my higher academic engagements. Finally, I owe my deepest gratitude to Funda, my muse and dear wife. She encouraged me to restart my unfinished Ph.D. program and gave her love and support during those long years of academic work without a word of complaint.

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

CAPM	Capital Asset Pricing Model
MSCI	Morgan Stanley Capital International
OLS	Ordinary Least Squares
BIST	Borsa Istanbul
XU100	BIST-100 Price Index
SLB-CAPM	Sharpe, Lintner and Black Capital Asset Pricing Model
DER	Debt/Equity Ratio
B/M	Book-to-Market Ratio
SMB	Small Minus Big Risk Factor
HML	High Minus Low Risk Factor
RMW	Robust Minus Weak Risk Factor
CMA	Conservative Minus Aggressive Risk Factor
APT	Arbitrage Pricing Theory
PCA	Principal Component Analysis
M&A	Mergers and Acquisitions
MCAP	Market Capitalization
CML	Capital Markets Law
CMB	Capital Markets Board
TKYD	Turkish Institutional Investment Managers' Association
ISE	Istanbul Stock Exchange
TCMB	The Central Bank of Turkey
ETF	Exchange Traded Funds
FED	The Federal Reserve Bank of the United States of America

ECB	European Central Bank
EU	European Union
AHM	Arnott, Hsu and Moore

CHAPTER 1

INTRODUCTION

Out of many general equilibrium models of the pricing of capital assets, the capital asset pricing model (CAPM), which was initially developed by Sharpe (1964) and Treynor (1961) and extended and clarified by Lintner (1965), was a major cornerstone of asset pricing theory. The model flawlessly demonstrates precise and testable predictions about risk and return with its simple logic and intuition. Hence, it is no coincidence that it was rigorously taught in MBA-level investment courses for over forty years and is still widely used as a practical tool in estimating the cost of equity and as a performance evaluation tool for managed portfolios. Unfortunately, in contrast to its simplicity, the empirical record of the model is relatively poor(even bearing the potential to invalidate its usage in practical applications). The model's empirical problems come either through true failings or due to shortcomings of the empirical tests, the leading of which was the usage of inferior proxies for the market portfolio.

Traditional CAPM tests use a cap-weighted equity market portfolio. A majority of these tests have found that either the CAPM relationship does not hold(a true failing of the model), or the equity market portfolio is not a good proxy of the CAPM market portfolio, which directly challenges the mean-variance optimality of the market portfolio. As cap-weighted indexes bear a natural bias towards large-cap and overpriced stocks, they have relatively limited exposure to underpriced (i.e., value) stocks. Hence it is not surprising that a cap-weighted equity market portfolio is not the best CAPM market proxy. Many index-based techniques have been

introduced in recent years, like smart (alternative) beta index investing and factor investing, in order to overcome this bias and unlock the potential for value investing,

This study challenges CAPM's original conviction that a passive investor/manager can do no better than holding a market portfolio in the context of the Turkish equity market. According to CAPM, generating a positive alpha through an active investment strategy is impossible, and generating a positive alpha is probably an outcome of the chance factor. To challenge this conviction, we followed the footsteps of the groundbreaking article of Arnott, Hsu, and Moore (2005), which first introduced the concept of smart (or alternative) beta indexing, as well as Ang, Goetzmann, and Schaefer (2009)'s study which first puts forefront the term of "Factor Investing." We limited our analysis to the Turkish equity market.

In this study, the research question of whether a positive alpha generation is possible in the long term using Smart Beta Index Investing and Factor Investing techniques is explored. Arnott et al. (2005)'s methodology and the general framework prescribed in the MSCI Factor Investing Guidelines are mimicked to the extent possible in constructing the Smart Beta and Factor Investing model portfolios with slight variations to the original constructs.

The research methodology incorporated a long-only portfolio approach for Arnott et al. (2005)'s fundamental indexation technique and a long-only and zero-cost(long-short) portfolio approach for Factor Investing. The zero-cost portfolios' yearly portfolio returns are calculated with reference to the difference between 30th and 70th percentile. The theoretical construct has been used to select which portfolio's return is deducted from what in calculating zero-cost return differences. The positive zero-cost portfolio returns indicate a distancing from mean reversion and may suggest a price anomaly.

We used Jensen's ordinary least squares (OLS) regression methodology, and excess return formula to detect pockets of mispricing in risk factor portfolio returns expected to yield Jensen's alpha. As CAPM dictates a linear relationship between the systematic risk and the portfolio's expected return, ordinary least squares regression is the best candidate suiting the job, as indicated in Jensen's (1968) pioneering work on managed portfolios.

The primary market proxy in this study is selected to be BIST-All Share Total Return Price Index-(XUTUM_CFNNTLTL). However, as the BIST-All Share Total Return Price Index series is only available through 31 October 2000, custom monthly total return index readings have been calculated and used for the earlier periods. Using a total return price index as the reference market portfolio is a sensible choice from the perspective of the CAPM theory and therefore used in a myriad of groundbreaking work by the finance academia. However, almost all of the past academic analyses on the Turkish equity market used XU100 (BIST-100) Price Index as the market proxy, perhaps due to the unavailability of a total return price index series overlapping the underlying period. The use of a price index as a market proxy contradicts CAPM's theoretical construct and carries the potential of creating a series of misrepresentations. For instance, using a stock price index instead of a total return price index as the reference market portfolio may deliver statistically significant Jensen's alphas. Suppose this is due to understated price index readings, which lead to overstated excess returns. In that case, this indicates how selecting a wrong market proxy can easily result in a misleading and false sense of security regarding statistical results. In reality, the statistical findings delivering abnormal returns may either be statistically insignificant or overstated considerably. We replicated the same statistical exercise using the alternative market proxies, namely,

the total return index series, XUTUM_CFNNTLTL, and XU100 (BIST-100) price index series, concurrently in order to show and elaborate on the stark differences expected in the least-squares regression results.

Using the total return index as the reference market portfolio instead of benchmarking on a common stock price index plays a vital role in this empirical study. The incorporation of dividend reinvestments in index data plays a crucial role in equating and comparing the returns of dividend-paying firms and their income retaining counterparts. The firms who retain the distributable income for internal use reinvest the funds reserved for cash dividends into other business opportunities. Hence, using a total return index as the reference market portfolio effectively addresses the comparability problem and eliminates an unwarranted bias favoring non-dividend-paying firms. Another comparability problem arises if a common stock price index is used as the reference market portfolio. As the risk factor portfolios are formed to account for dividends, the risk factor portfolios and the reference market portfolio do not share the same return characteristics and, therefore, are not comparable. Therefore, using the total return index is instrumental in eliminating an inherent design flaw of stock price indexes in tracking holding period returns. Stock price indexes are formulated to deflate in value to reflect the deduction of cash dividends from the index figures whenever a dividend payout occurs.

The main academic objective of this study is to replicate the findings of Arnott et al. (2005) and Ang et al. (2009) report (using a Morgan Stanley-Capital International (MSCI) inspired factor investing model) in the Turkish context. We tried to detect whether there are pockets of mispricing opportunities (equals to alpha in the CAPM context) in the Turkish equity market that the classical CAPM framework can not explain. Depending on the success of the replicated models in

generating long-term alpha, the results of this study may encourage the Turkish pension fund management industry to capitalize on some form of fundamental indexing.

CHAPTER 2

LITERATURE REVIEW

2.1 The capital asset pricing model (CAPM)-(Sharp-Lintner and Black versions)

The Sharp-Lintner CAPM found its roots in Harry Markowitz's (1952, 1959) mean-variance portfolio model. Markowitz's model assumes that (i) investors have access to all the available information regarding the expected return, variances, and covariances of securities or assets, (ii) investors are risk-averse individuals who maximize the expected utility of their wealth and only care about the mean and variance of their one-period investment return when they select among a pool of portfolios bearing different risk and return profiles. Hence, according to Markowitz, investors are inclined to choose mean-variance efficient portfolios. This model characteristic means that (i) mean-variance efficient portfolios minimize portfolio return variance, $s^2(R_p)$, given expected return, $E(R_p)$, and (ii) they also maximize expected return given variance.

CAPM requires that the expected return and risk of a portfolio should have a linear relationship, i.e., the expected return on any asset i and its beta risk in portfolio e should produce a linear relationship. This linear relationship manifests itself when allocating investments among assets to minimize return variance while delivering expected portfolio return $E(R_e)$;

$$E(R_i) = E(R_{ze}) + [E(R_e) - E(R_{ze})]\beta_{ie}\,, \quad i = 1, \dots, N, \tag{1a}$$

$$\beta_{ie} = \frac{Cov(R_i,R_e)}{\sigma^2(R_e)} = \frac{\Sigma_{j=1}^{N} x_{je}\, Cov(R_i,R_j)}{\Sigma_{i=1}^{N} x_{ie}\, \Sigma_{j=1}^{N} x_{je}\, Cov(R_i,R_j)} \tag{1b}$$

In the above equations, Cov denotes covariance, $E(R_{ze})$ is the expected return on assets whose returns are uncorrelated with the return on portfolio e (they have Cov(Ri,Re) = 0). According to Markowitz's model, a portfolio's risk is the variance of its return, so the risk of portfolio e is $s^2(R_e)$. The variance on the portfolio return is the sum of the weighted covariances of each asset's return with the portfolio return,

$$\sigma^2(R_e) = \Sigma\, x_{ie}\, Cov(R_i, R_e) \qquad (2)$$

Hence, the beta risk of asset i, $\beta_{ie} = Cov(R_i, R_e)/s^2(R_e)$ is the covariance risk of asset i in portfolio e. It is a measure relative to the risk of the portfolio, which is the average of the covariance risks of all assets. Equation (1a) is the algebraic result of the condition on asset weights that produces the minimum variance portfolio with an expected return equal to $E(R_e)$. Essentially, the CAPM turns equation (1a) into a restriction on market-clearing prices and expected returns by pinpointing a portfolio that must be efficient if asset prices are to clear the market of all securities. If applied to such a portfolio, equation (1a) becomes a relation between expected return and risk that must hold in a market equilibrium. Hence through this algebraic condition on asset weights in mean variance-efficient portfolios, the CAPM provides a testable prediction regarding the risk-return relationship by identifying an efficient portfolio with the provision that asset prices are clearing the market for all assets.

Sharpe (1964) and Lintner (1965) modified the Markowitz model by introducing assumptions that help to identify whether a portfolio is mean-variance-efficient or not. The first assumption is "*complete agreement*." According to this assumption, investors are price-takers and have homogenous expectations about asset returns. If the market-clearing asset prices at t-1 are known, it is assumed that

investors have the exact expectations of the joint distribution of asset returns from t-1 to t. The second assumption is "*unlimited borrowing and lending"* at a risk-free rate. There exists a risk-free asset such that unlimited capital can be borrowed or invested at this risk-free rate. With these two assumptions in place, the Sharp-Lintner CAPM assesses that as investors have the exact expectations regarding distributions of returns, all investors see the same opportunity set, and they all invest in the tangency portfolio T with risk-free lending or borrowing. As all investors invested in the same portfolio T, this portfolio can be deemed the capitalization-weighted market portfolio of risky assets. Hence, each risky asset's weight in the tangency portfolio, which should be no other than the "market" itself, must be the total market value of all outstanding asset units divided by the total market value of all risky assets. Additionally, the risk-free rate must (along with the prices of risky assets) clear the market for risk-free borrowing and lending.

It is pretty straightforward that unrestricted risk-free borrowing and lending are unrealistic assumptions. Apart from funding availability, an unlimited ability to borrow does not imply that CAPM investors choose to use that ability to take an infinite position in any asset. Their wealth and preferences limit their borrowing to purchase assets in the context of a fixed short-run supply curve. Increased demand for an asset raises the market price, limiting investors' preference for the asset. An equilibrium means all are happy with their asset holdings when they stop purchasing assets and, thus, do not need further borrowing. Although CAPM investors may have access to unlimited borrowing, the pricing mechanism limits their desire to borrow. In order to test whether CAPM can be theoretically valid without unlimited risk-free borrowing and lending assumptions, Fischer Black (1972) introduced a new version of the CAPM, where unrestricted short sales of risky assets attained the mean-

variance efficiency of the market. According to Black, investors select portfolios along the mean-variance-efficient frontier without a risk-free asset. The market portfolio, this time, consists of the aggregate of efficient portfolios chosen by the investors. As a market portfolio consists of efficient portfolios, it becomes efficient, and therefore the minimum variance condition and the expected return-risk relationship of CAPM hold. The unlimited short sales assumption of Black CAPM bears a similar shortcoming due to its unrealistic nature, as in the case of the unlimited borrowing and lending assumption of Sharpe-Lintner CAPM.

In brief, Sharp-Lintner and Black versions of CAPM(shortly referred to as SLB-CAPM) require that all investors (a) are rational (i.e., they seek to maximize their economic utility or wealth); (b) are risk-averse; (c) focus on two primary asset characteristics, i.e., expected return and risk (as measured by variance in rates of return) – when making portfolio decisions; (d) possess identical full knowledge and process it correctly to form homogeneous, correct beliefs about current and future returns, variances of returns and covariances of returns (each of which has normal distribution about their mean values); (e) can borrow and lend with no limit at the risk-free rate; (f) can short sell risky assets with no limits; (g) invest over one, and the same, holding period. In addition to these assumptions regarding investor perceptions, SLB-CAPM also assumes that there are no frictions in portfolio formation, i.e., there are no taxes; no transaction costs; and no other illiquidities (assets are fully marketable and infinitely divisible) which add to CAPM's fragility in terms of empirical validity.

2.2 CAPM empirical tests

Under CAPM, the efficiency of the market portfolio requires either unrestricted risk-free borrowing and lending (the Sharpe-Lintner CAPM) or unrestricted short selling of risky assets (the Black version of CAPM). The absence of a risk-free asset and restrictions on short sales of risky assets put the efficient portfolio hypothesis at risk. Due to the unrealistic nature of the above assumptions plaguing both Sharpe-Lintner and Black versions of CAPM, the market portfolio is inefficient, so the CAPM risk-return relation should not hold. Many papers challenge the CAPM prediction that the market portfolio is efficient with such conviction in mind. The evidence comes from tests on the basic prediction of CAPM that (1) there is a linear relationship between the expected returns on all assets and their market betas, and (2) no other variable has marginal explanatory power. According to empirical CAPM tests, several variables other than beta add to the explanation of expected returns provided by market beta. Basu (1977) provided evidence that the low P/E portfolios earned more than that implied by their levels of risk, contrary to the predictions by CAPM, while the high P/E portfolios earned less than that implied by their levels of risk. Banz (1981) found a size effect; when stocks are sorted according to their market capitalization, average returns on small stocks are considerably higher, contrary to what CAPM suggested. Bhandari (1988) found that the expected returns on common stocks are positively related to the debt/equity ratio (DER), controlling for the beta and firm size. Finally, the relation between average return and the book-to-market ratio (B/M, the ratio of the common shareholder equity to its market capitalization) also suggests that the market portfolio is inefficient. High B/M stocks have high average returns that are not captured by their betas, and the average returns on low B/M stocks are lower than implied by their betas (Statman (1980), Rosenberg, Reid, and Lanstein (1985))

2.3 Models with additional risk factors complementing CAPM beta

2.3.1 Fama-French three-factor model

In their groundbreaking study, which uses a cross-section regression approach, Fama and French (1992) confirm that size, earnings-price, debt-equity, and book-to-market ratios add to the explanation of expected stock returns provided by market beta. Fama and French (1992) validate the findings of earlier studies (Reinganum (1981); Stambaugh (1982); Lakonishok and Shapiro (1986)) that the linear relationship between average return and beta shows a tendency to become flat. The evidence put forth by Fama and French's (1992) study shed light on the empirical deficiencies of CAPM and catalyzed the general acknowledgment that the CAPM has potentially fatal problems.

Fama and French (1993) argued that though size and book-to-market risk factors are deemed state variables, the higher average returns on small and high book-to-market stocks reflect unknown state variables. Those unknown state variables produce non-diversifiable risks (covariances) in returns like the beta. However, those pockets of mispricings are not captured by the market return and are priced separately from market betas. In support of their claim, they show in their empirical findings that the returns on small firms covary more with their class than the returns on large firms. Similarly, returns on high book-to-market (value) stocks covary more with one another than with returns on low book-to-market (growth) stocks.

Based on these findings, Fama and French (1993, 1996) propose a three-factor model for expected return:

$$E(R_{it}) - R_{ft} = \beta_{im} - \left[E(R_{mt} - R_{ft}\right] + \beta_{is}E(SMB_t) + \beta_{ih}E(HML_t) \qquad (3)$$

Fama and French added SMB_t (small minus big), the difference between the returns on small and big stocks, and HML_t (high minus low), the difference between the returns on high and low B/M (Book-to-market) stocks, to the CAPM equation as new risk factors. In the equation, the betas are slopes in the multiple regression of $R_{it} - R_{ft}$ on $R_{mt} - R_{ft}$, SMB_t, and HML_t.

Fama and French's construct requires that the intercept α_i in the time-series regression of the three-factor model is zero for all assets i.,

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}\left(R_{Mt} - R_{ft}\right) + \beta_{is}SMB_t + \beta_{ih}HML_t + \varepsilon_{it} \qquad (4)$$

Fama and French (1993, 1996) show that the three-factor model successfully captured much of the unexplained variation in average return for size, book-to-market equity, and other price ratios. Fama and French (1998) also show that an international version of the model performs better in describing average returns on portfolios for stocks in 13 major markets. The three-factor model is now widely accepted as a viable tool in empirical research that requires a model of expected returns. Estimates of α_i from the Fama-French time-series regression find its use as a calibration to show the responsiveness of stock prices to new information (for example, Loughran and Ritter (1995); Mitchell and Stafford (2000)). They are also used to measure portfolio managers' performance. For instance, Carhart (1997) used it in his seminal study of mutual fund performance. The model also sees its use among practitioners like Ibbotson Associates. It's been suggested as a tool for estimating the cost of equity capital.

The three-factor model's success derives from a theoretical perspective by capturing covariation in returns missed by the market return. The model successfully picked up much of the size and value effects in average returns unexplained by the CAPM. However, according to Fama and French (1993, 1996), the model has some design flaws in selecting state variables. The SMB and HML risk factors are explicitly designed to capture the variation in stock returns attributable to size and the book-to-market equity ratio rather than based on investor predictions.

2.3.2 Carhart four-factor model

Another shortcoming of the Fama-French three-factor model is its omission of the momentum effect of Jegadeesh and Titman (1993). Jegadesh and Titman (1993) showed that stocks that do well relative to the market over the last three to twelve months continue to perform well for the next few months, and underperforming stocks continue to perform poorly. The momentum effect is distinguishable from the value effect captured by book-to-market equity and other price ratios. Moreover, the momentum effect is left unexplained by the three-factor model and the CAPM. Carhart (1997) attempted to find a panacea for this shortcoming by adding a momentum factor (the difference between the returns on short-term winners and losers) to the three-factor model. This step is again legitimate in applications where the goal is to abstract from known patterns in average returns to uncover information-specific or manager-specific effects. However, since the momentum effect is short-lived, it is mainly irrelevant for estimates of the cost of equity capital.

2.3.3 Fama-French five-factor model

Since its introduction in 1993, the Fama-French three-factor model has had difficulty explaining the cross-sectional variation in expected returns primarily related to profitability and investment, among other anomalies. Fama and French argue that numerous scholarly work reveals the relationship between average stock returns and B/M, book-to-market equity ratio. There is also enough evidence that profitability and investment factors add explanatory power to the description of average returns provided by B/M. Fama and French (2015) assert that the dividend discount model can be utilized in explaining this relationship. The dividend discount model suggests that the market value of a share of stock is determined by the discounted value of expected dividends per share. Based on this body of empirical evidence, Fama and French (2015) add profitability and investment factors to the three-factor model and arrive at the following five-factor model,

$$R_{it} - R_{ft} = a_i + b_i\left(R_{Mt} - R_{ft}\right) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{it} \quad (5)$$

In this equation, RMW_t risk factor denotes for the difference between the returns on portfolios of stocks with robust profitability and portfolios of stocks with weak profitability. CMA_t risk factor denotes the difference between the returns on portfolios of the stocks of low investment (conservative) and high investment (aggressive) firms. If the exposures to the five factors, b_i, s_i, h_i, r_i, and c_i, capture all variation in expected returns, the intercept, a_i is zero for all securities and portfolios i.

Fama and French (2015) test the performance of the five-factor model for the U.S. market by utilizing the data from July 1963 to December 2013. Their findings suggest that a five-factor model performs better than the three-factor model of Fama and French (1993). Nonetheless, the five-factor model fails to capture price variations, leading to low average returns on small stocks that invest a lot despite low profitability. Furthermore, the findings suggest that the value factor (HML) becomes redundant with the two additional factors.

2.4 Cap-weighted indices vs. fundamental indexation (smart beta investing)

The CAPM market portfolio should theoretically include all assets available for investment, with a weight relative to their total presence in the market. Thus, the true market portfolio should include all stocks(U.S. and others), all kinds of debt securities, commodities, real estate, artworks, intellectual rights, financial instruments backed by physical assets, and any other tradeable assets, including human capital. Hence, a globally diversified all-asset portfolio is closer to being mean-variance efficient than a diversified stock portfolio. Mayers (1976) had a pioneering role in prescribing that the CAPM market portfolio should include all assets in positive net supply. Therefore, the equity market portfolio alone can not be a reasonable proxy for the CAPM market portfolio. Perhaps due to this mismatch, traditional CAPM tests using a cap-weighted equity market portfolio have found the CAPM relationship not to hold. This failure is either due to a rejection of the equity market portfolio as the correct proxy to the CAPM market portfolio or rejection due to failing to fulfill the mean-variance optimality condition. Stambaugh (1982) put Mayers' idea to the test and used a CAPM market portfolio that included non-equity asset classes. The result was a considerable improvement over traditional CAPM

tests. Roll and Ross (1994) stated that tests aiming to find a positive and exact cross-sectional relation between ex-ante expected returns and betas turned out to be unsuccessful. This condition should hold if the market is found to have lied on the positively sloped segment of the mean-variance efficient frontier. Hence not finding a positive cross-sectional relation suggests that the index proxies used in empirical testing are not ex-ante mean-variance efficient. Ross (1978), argued that the mean-variance efficiency of the market portfolio is not generally sustained in a broader context if CAPM is extended beyond its original framework. Gibbons (1982), using a multivariate regression framework, concluded that with no additional variable beyond beta, the substantive content of the CAPM is rejected for the period 1926-1975 with a significance level of less than 0.001. Jobson and Korkie (1982), Shanken (1985), Kandel and Stambaugh (1987), Gibbons, Ross and Shanken (1989), Zhou (1991), and MacKinlay and Richardson (1991) are among the academicians rejecting the mean-variance efficiency of cap-weighted market indexes.

In Arnott et al.'s (2005) groundbreaking article, a widely accepted and followed predicament of CAPM suggesting that a passive investor/manager can do no better than holding a market portfolio is challenged. Many academic papers listed above have already challenged using cap-weighted indexes as the best possible CAPM market proxies. Their objection to this idea is equivalent to rejecting the mean-variance efficiency of those indexes. Arnott et al. agree that the ex-ante construction of a mean-variance efficient portfolio is a daunting task. The hardship of this work is precisely why the asset management industry and certain academic circles believe that cap-weighted equity market indexes represent the CAPM market portfolio best and are nearly mean-variance efficient. However, Arnott et al. object to using cap-weighted indexes as CAPM market proxies to provide the best solution.

They assert that Fundamental equity market indexes capable of delivering superior mean-variance performance than cap-weighted equity market indexes can be provided.

Arnott et al. suggested the construction of fundamental indexes that utilize gross revenue, book value, trailing five-year average cash flow, trailing five-year average revenue, trailing five-year average gross sales, trailing five-year average gross dividends, and total employment. Absolute values of each factor are used as weights for each stock comprising the indexes rather than their market capitalization. It was shown that the fundamentals-weighted indexes provided higher returns and lower risks than the cap-weighted equity market indexes.

There are seemingly considerable merits in using capitalization weighting as a passive strategy, and any alternative strategy should provide the same benefits to become a viable substitute.

The first and most important attribute of capitalization weighting is comparably minor trading requirements. Implementing an index-tracking strategy requires far lower trading costs and management fees than an active strategy. Apart from stock buybacks and secondary equity offerings, the only rebalancing cost is the cost of replacing constituent securities in the portfolio.

The second important attribute of a cap-weighted index strategy is the ease of participation in the equity market in a broader sense. As a natural tendency, capitalization weighting emphasizes large companies by providing larger weights to the larger companies. Large capitalization companies are also among the largest firms as measured by other size metrics like sales revenue, shareholders' equity, cash flow from operations, dividend payments, and the number of employed personnel.

As a third attribute, market capitalization is highly correlated with trading liquidity. Hence cap-weighting is inclined to emphasize the more heavily traded stocks, thereby easing portfolio transactions and lowering transaction costs.

Lastly, as market capitalization is highly correlated with investment capacity, cap-weighting is inclined to emphasize stocks with greater investment capacities. Because of this trait, large pension funds and institutions use passive indexing on an immense scale

In order to present itself as an alternative strategy, Fundamental Indexation should retain many of the benefits offered by cap-weighting. The alternative measures of company size like book value, cash flow, sales, revenues, dividends, or employment are highly correlated with capitalization and liquidity. This correlation provides a concentration in favor of large-cap stocks and gives Fundamental Indexes an edge to preserve traditional cap-weighted indexes' liquidity and capacity benefits.

In terms of riskiness, it is safe to assert that Fundamental indexes have substantially identical volatilities to conventional cap-weighted indexes. Hence, market characteristics that investors have traditionally gained exposure to by holding cap-weighted market indexes are equally accessible via Fundamental indexes. However, it is noteworthy that there are a couple of shortcomings. Maintaining a comparatively low turnover is challenging in managing portfolios replicating Fundamental indexes. Compared to cap-weighted index tracking, a relatively higher amount of rebalancing is needed for the usual reconstitution of Fundamental indexes.

2.5 Factor investing

"Factor Investing" is an investment strategy that combines an active management style with passive investing to capture excess returns to provide higher returns and lower risks than the traditional cap-weighted equity market indexes. Factor investing has inherited some of the advantages of passive investing, as transaction costs are low, as in the case of passive investing. It also somehow resembles active management styles as it aims to provide returns above the market-cap-weighted index. Factor Investing has become a hot topic among investors, asset management practitioners, and academia. Factor investing aims to capture exposures to various equity risk premia. A factor can be defined as any characteristic attributed to a group of securities that is instrumental in explaining their return and risk.

Many academic research highlights that risk factors can explain long-term equity portfolio performance. Perhaps a leading study that contributed to this line of work was Ross's (1976) "Arbitrage pricing theory" (APT). "Arbitrage pricing theory" (APT) asserts that the expected return of a financial asset is a function of various macroeconomic factors. "Factors," which are defined as variables other than the beta that affect the expected return of an asset, have initially been used as a term in Ross's (1976) study. The term's popularization was also due to his original model called the "multi-factor model." As Ross (1976) refrained from explicitly specifying these factors, the challenge of constructing factor models became purely empirical. Another early study in this line of work was the theory developed by Barr Rosenberg and Vinay Marathe (1976). Rosenberg et al.'s (1976) theory assert a linkage between macroeconomic events' effects on individual securities and microeconomic characteristics-essentially common factors, such as industry membership, financial structure, or growth orientation.

A renewed interest in the field was perhaps due to the financial meltdown of 2008. This financial crisis wiped out more than USD two trillion from the global economy. In the aftermath of the meltdown, institutions governing or managing country funds and asset managers in charge of long-term managed wealth like pension funds were urged to uncover what went wrong in terms of their asset management practices and risk assessment procedures. Some of the answers to these questions were highlighted in Ang et al. (2009) report. The Norwegian government asked Ang et al. to evaluate the active management performance of Norway's sovereign fund. In this groundbreaking study, risk factors are defined as building blocks that explain the returns of various assets which combine these building blocks.

Those who believe in factor investing think it is wiser to build a portfolio that bases its allocation on factors rather than asset classes. Asset classes are naturally correlated due to their underlying exposure to these common risk factors. For example, equity and high-yield corporate bonds are two asset classes with different degrees of exposure to equity risk and are highly correlated. Furthermore, this correlation between asset classes is amplified during crises, when the market risk (or equity risk) prevails over all other risks (Brière et al., 2012). Increased market risk has led many investors to question the conventional strategies relying on allocations based on asset classes. They started to focus more on methods to diversify the sources of fundamental risk or risk factors. In theory, a risk factor is a pure exposure to an underlying risk that is supposed to produce a risk premium. In practice, there are several coexisting notions of factors: macroeconomic factors, statistical factors that result from principal component analysis (PCA) or other forms of statistical

analysis, style factors (size, value, momentum, and others) that result from the dynamic, systematic selection of individual securities (equity, or more recently corporate bonds), depending on their characteristics. The literature has identified more than 300 style factors for equity alone (Harvey et al., 2014). Out of a myriad of factors, a few bunches can earn a long-term risk premium commensurate with their exposure to systematic risk. Hence Factor Investing is the means to harvest these risk premia through exposure to factors.

Ang later asserted in his book-“Factor Investing," that a large body of academic literature, and long investing experience, suggest that certain classes of equity, debt, and derivative securities have higher pay-offs than their reference markets. According to Ang, stocks with relatively low prices compared to their fundamentals (value stocks) beat stocks with relatively high prices compared to their fundamentals (growth stocks) over long periods, giving rise to a value-growth premium. Likewise, stocks with past high returns (winners) out-perform stocks with low or negative past returns (losers), leading to momentum strategies. There are illiquid securities that trade at low prices and have high average excess returns relative to their more liquid counterparts. Thus, there is an illiquidity premium. Bonds tend to have higher average returns reflecting a credit risk premium with higher perceived default risk. Moreover, because investors are willing to pay for protection against high volatility periods when returns tend to crash, sellers of volatility protection in options markets earn high returns.

Ang combines long positions in these classes of securities with under-weight or short positions in the securities that are expected to underperform. Thus, he asserts that premiums can be collected based on:

- Value-Growth Premium = Value stocks minus growth stocks
- Momentum Premium = Winning stocks minus losing stocks
- Illiquidity Premium = Illiquid securities minus liquid securities
- Credit Risk Premium = Risky bonds minus safe bonds
- Volatility Risk Premium = Selling out-of-the-money puts offset by stocks or calls to produce market-neutral positions

According to Ang, these are dynamic factors because they involve time-varying positions in securities that change over time. While dynamic factors often beat the market over long periods, they can grossly underperform it during specific periods – like the 2008-2009 financial crisis. Factor risk premiums exist in the long run because they compensate the investor for bearing losses during bad times.

The investment industry often uses the terms smart Beta, alternative Beta, or exotic Beta for dynamic factors. Hence it is safe to assert that smart beta investment strategies and factor investing are closely related in mechanics and content.

2.6 MSCI factor investing model

Fundamental analysis that aims to determine a security's future value should entail a combination of macro and microeconomic events and company-specific characteristics. Institutional investors commonly acknowledge that there are common factors affecting all stocks. Macroeconomic events, like sudden changes in interest rates, inflation, or exchange rates, can affect all stocks, depending on the stock's characteristics. The most widely used factors used to detect company-specific characteristics were fundamental factors. Rosenberg et al.'s (1976) assert a linkage between the effects of macroeconomic events on individual securities and

microeconomic characteristics – essentially common factors, such as industry membership, country membership, financial structure, or growth orientation. Value, Growth, Size, and Momentum factors have been popular subjects of interest as stock characteristics among finance academia for over a couple of decades. Hence, an extensive body of research has been based on these factors constituting an essential part of the asset pricing literature. Rosenberg et al. (1976) were among the pioneers to describe the importance of these stock characteristics in explaining stock returns, eventually leading to creation of the multi-factor Barra risk models. Factors like Value, Growth, Size, and Momentum have a historical track record of earning long-term risk premiums in return for their exposure to systematic sources of risk. Hence, factor investing is one of the promising investment tools that can help harvest these risk premia through exposure to factors.

MSCI academics Bender, Briand, Melas, and Subramanian R.A. (2013), identified six equity risk premia factors: *Value*, *Low Size*, *Low Volatility*, *High Yield*, *Quality,* and *Momentum*. According to Bender et al., these risk factors are grounded in academic research and have solid explanations for their potential to deliver premiums historically

.Following the footsteps of academic research in the field, MSCI has introduced a multitude of factor indexes, as shown in Table 1, intending to reflect the performance of those six equity risk premia factors.

Table 1. MSCI Risk Premia Factors

Systematic Factors	Its Function	Fundamental Metrics
Value	➢ Aims to capture excess returns of stocks trading at prices lower than their fundamental value.	➢ Uses fundamental metrics such as book-to-price, earnings-to-price, book value, sales, earnings, cash earnings, net profit, dividends, and cash flow.
Size (Small Cap)	➢ Aims to capture excess returns of smaller firms (by market capitalization) relative to their larger counterparts.	➢ Uses market capitalization (total or free float).
Momentum	➢ Aims to capture excess returns to stocks with more robust past performance.	➢ Uses relative returns (3-mth, 6-mth, 12-mth, sometimes with the last one month excluded) and historical alpha.

Systematic Factors	Its Function	Fundamental Metrics
Volatility	➢ Aims to capture excess returns to stocks with lower than average volatility, beta, and unsystematic risk.	➢ Uses standard deviation (1-yr, 2-yrs, 3-yrs), downside standard deviation, the standard deviation of unsystematic returns, and beta.
Dividend Yield	➢ Aims to capture excess returns to stocks that have higher-than-average dividend yields.	➢ Uses dividend yield.
Quality	➢ Aims to capture excess returns to stocks that are characterized by low debt, stable earnings growth, and other "quality" metrics.	➢ Uses ROE, earnings stability, dividend growth stability, the strength of balance sheet, financial leverage, accounting policies, the strength of management, accruals, and cash flows.

Indexation proved to be an efficient, transparent, and cost-effective way to access fundamental factor investing. As factor allocations are based on factor indexes and can be implemented passively, factor investing may provide sizeable cost savings to institutional investors. Investing through factor indexes provides for a transparent investment scheme and ease of risk management, which may help alleviate the well-known shortcomings of active portfolio management like, manager style drifts.

2.7 Previous academic work on the application of fundamental indexation to the turkish stock market

Küçükşahin and Coşkun (2020) analyzed the performance of the fundamental indexes based on fundamental risk factor portfolios constructed according to the fundamental metrics of stocks listed on the BIST. They used assets, sales, book value, operating profit, and net profit figures in the financial statements to construct the fundamental index portfolios. They used these fundamental metrics as weights in the relevant fundamental indexation portfolios. In addition to the fundamental indexes, a composite index and an equally-weighted index were also formed. They selected the BIST-100 cap-weighted stock price index as the reference market portfolio. The portfolios are composed for the period 2001-2015. According to their findings, the fundamental indexes based on assets, book value, operating profit, net profit, and the indexes created by the five-year averages of these fundamental variables yield higher returns in the long term than BIST-100 cap-weighted index. The alphas of these fundamental indexes are also statistically significant.

CHAPTER 3

RESEARCH OBJECTIVES AND METHODOLOGY

This study aimed to challenge CAPM's original conviction that a passive investor/manager can do no better than holding a market portfolio. According to CAPM, generating a positive alpha through an active investment strategy is impossible, and any such achievement should be attributed to the chance factor. To challenge this conviction, we have followed in the footsteps of the groundbreaking article of Arnott et al. (2005), which first introduced the concept of smart(or alternative) beta indexing, as well as Ang et al. (2009)'s study which first puts forefront the term of "Factor Investing." Our analysis is limited to the Turkish equity market.

We have tested the research question of whether a positive alpha generation is possible in the long term using Smart Beta Index Investing and Factor Investing techniques. We mimicked to the extent possible Arnott et al.'s (2005)'s methodology and the general framework as prescribed in the MSCI Factor Investing Guidelines in constructing the Smart Beta and Factor Investing model portfolios.

3.1 The regression model

This study uses the time-series regression approach of Jensen (1968). Jensen (1968) referred to the independently derived CAPM models of Sharpe (1964), Lintner (1965), and Treynor (Undated). He assessed that the main results of these models are somewhat identical, and they point to the direct relation between the expected risk premiums on individual assets and their "systematic risk ." The expected one-period return of the CAPM models, $E(\tilde{R}_j)$, on any security (or portfolio) is defined below;

$$E(\tilde{R}_j) = R_{ft} + \beta_j[E(\tilde{R}_m) - R_{ft}] \quad (6)$$

and the expected excess returns on the *j*th asset, is the ratio of the total of capital gains and dividends to the initial price of the security, are:

$$E(\tilde{R}_j) = \frac{E(\tilde{P}_t) - P_{t-1} + E(\tilde{D}_t)}{P_{t-1}} - R_{ft} \quad (7)$$

where;

$\tilde{D}_t$= dividends paid on the *j*th security at time *t*

R_{ft}= the one-period risk-free rate of interest

$E(\tilde{R}_m)$= expected excess returns on a "market portfolio."

$\beta_j = \frac{cov(\tilde{R}_j, \tilde{R}_m)}{\sigma^2(\tilde{R}_m)}$= the systematic risk of the *j*th asset

According to CAPM, the above expressions state that the expected return on any asset is equal to the total of the risk-free rate and a risk premium given by the product of the systematic risk of the asset, β_j, and the risk premium on the market portfolio. Jensen (1968) extended the CAPM models of Sharpe, Lintner, and Treynor to a multi-period scheme in which diverse horizon periods can exist, and the trading of securities can now take place continuously through time. If we assume a multi-period investment universe and use ex-post excess returns instead of expected excess returns, the equation becomes as follows;

$$\tilde{R}_{jt} = R_{ft} + \beta_j[\tilde{R}_{mt} - R_{ft}] + \tilde{e}_{jt} \quad (8)$$

Here $\tilde{e}_{jt}$ is a random error that has an expected value of zero. If we subtract R_{ft} from both sides of the equation, then it becomes;

$$\tilde{R}_{jt} - R_{ft} = \beta_j\left[\tilde{R}_{mt} - R_{ft}\right] + \tilde{e}_{jt} \quad (9)$$

According to Jensen (1968), a performance measure for a managed portfolio can be traced by not constraining the regression equation to pass through the origin. If the asset manager has superior forecasting ability, he is expected to select securities that realize $\tilde{e}_{jt}>0$ systematically. In this case, to detect this anomaly, there should be an addition of a non-zero constant to the equation, α_j. The regression equation then becomes;

$$\tilde{R}_{jt} - R_{ft} = \alpha_j + \beta_j\left[\tilde{R}_{mt} - R_{ft}\right] + \tilde{u}_{jt} \quad (10)$$

The new error term $\tilde{u}_{jt}$ should satisfy the condition $E(\tilde{u}_{jt}) = 0$, and be serially independent. If the asset manager has a superior forecasting ability, then $\alpha_j>0$. The intercept that was later given the name Jensen's alpha should be zero for every asset (or portfolio) in order for CAPM to hold.

Black, Jensen, and Scholes (1972) used a similar approach in their study of the CAPM test of the traditional form of the model. According to their findings, the time-series regressions of the portfolio excess returns on the market portfolio excess returns show that high-beta securities are inclined to have significantly negative intercepts and low-beta securities had significantly positive intercepts, contrary to the predictions of the traditional form of the model.

Throughout the study, we used the same regression model as prescribed in Jensen's seminal paper to test for α_j.

3.2 Fundamental indexation

The Fundamental Indexation (Smart Beta Index Investing) section of this study aimed to replicate Arnott et al.'s (2005) construction of the fundamental indexes that originally used equity book value, gross revenue, gross sales, gross dividends, cash flow, and total employment as weights for the Turkish stock market. As a variation from the original construct, we decided to exclude gross revenue due to its similar traits with gross sales and the redundancies associated with this similarity. Due to the unavailability of data employment factor was discarded, and net sales were used instead of gross sales. We also did not form equal sample sizes (1000 stocks as in the case of Arnott et al.) among fundamental metrics due to a relatively low number of listings in the Turkish stock market compared to the US. We instead ranked all companies in the listings according to their fundamental metrics. Another variation from the original construct is the timing for rebalancing. Arnott et al. used the year-ends for rebalancing, and the holding period for fundamental index portfolios was selected to be one year. Although we stick with the holding period frequency, we used a six-month gap between the fiscal year-end and the holding period return calculations to ensure all accounting data were available. Although earlier academic works assume that accounting data are available from three or four months within fiscal year-ends, we tend to stick with the highly conservative Fama and French (1992) choice of portfolio formation timing. Perhaps another motive was streamlining the portfolio formation timing to match the Fama-French methodology as we intend to use Fama-French's Three-Factor model to test for Jensen's alpha.

Hence, holding period return calculations cover one year, starting from July and ending in June of next year.

Each fundamental metric will rank all listed companies. They were represented in each fundamental index according to their relative metric weight to create the Fundamental index for that metric. We tend to stick with the original construct of Arnott et al. and use trailing five-year averages for each metric other than the single-year metric of book value. If five years of data were not available, we used the average of available data. The five-year trailing averages helped eliminate unwanted volatility in fundamental index weights. The fundamental metrics used in the study as measures of company size are as follows:

- Year-end book value (Book)
- Trailing five-year average net sales (Sales),
- Trailing five-year average gross dividends (Dividends), and
- Trailing five-year average cash flow (Cash Flow),

An equal weight composite index is also constructed out of four fundamental metrics by taking the mean return of fundamental indexes.

3.3 Factor investing

An MSCI-inspired Factor Investing Model will be replicated for the Turkish stock market in the factor investing part of the study. MSCI has identified six equity risk premia factors: Value, Low Size, Low Volatility, High Yield, Quality, and Momentum and constructed a family of factor indexes designed to reflect the performance of those six equity risk premia factors. Likewise, we tested whether this

model will generate superior mean-variance performance than cap-weighted equity market indexes.

All companies will be ranked according to each factor metric. Model portfolios are formed to mimic each factor's style characteristics. The median values and 30th and 70th percentiles are used as breakpoints. According to the style characteristics, the stocks above or below the median value or above the 30th percentile or below the 70th percentile were selected to form the model portfolios. Their factor values are used as weights in the respective portfolios. The metrics that are used for each factor are listed below:

- Value-(*equal weight of book to price, net earnings to price, EBIT-DA rankings*)
- Small size-(*equal weight of total market capitalization and free-float market capitalization rankings*)
- Low volatility-(*equal weight of one-year daily standard deviation and Beta rankings*)
- High yield-(*gross dividend yield rankings*)
- Quality-(*equal weight of ROE, trailing five-year average earnings growth, and Financial leverage rankings*)
- Momentum-(*calculated every year-end. Cap-weight average of firms higher than the median value of 10-month returns lagging two months and cap-weight average of firms with the highest 30% of 10-month returns lagging two months*)

3.4 Long-only and long-short (zero-cost) portfolios

The research methodology incorporated a long-only portfolio approach for Arnott et al.'s (2005) fundamental indexation technique and a long-only and zero-cost(long-short) portfolio approach for Factor Investing. The zero-cost portfolios' yearly holding period returns are calculated according to their theoretical construct's guidelines. The breakpoints for long-only and zero-cost portfolios are selected to be the median value and the 30th and 70th percentile of data readings. The zero-cost returns are the difference between portfolio returns where the constituents of the relevant portfolios are either smaller or larger than the median value or larger than the 30th or smaller than the 70th percentiles. The theoretical construct has been used to determine the long-short portfolio construction mechanism and the calculation methodology for zero-cost portfolio returns. If a default event occurs in any given month during the lifetime of a long-short risk factor portfolio, whereby a short position can no longer finance a long position, the long-short risk factor portfolio in question is deemed to have defaulted. We look for a sizeable return in zero-cost portfolios as this will indicate a distancing from mean reversion and may suggest a price anomaly. Throughout the study, the zero-cost portfolios constructed according to the median breakpoint proved to be a much better choice in detecting pockets of mispricings.

The long-only portfolios, likewise the zero-cost portfolios, were constructed according to the theoretical guidelines for each factor investing risk factor. In line with zero-cost portfolios, long-only portfolios' yearly holding period returns are calculated according to the dictated selection criteria in the theoretical construct. Hence, the constituents of the relevant portfolios are selected regarding their ranked factor readings. They are either smaller or larger than the median breakpoint or larger

than the 30th and smaller than the 70th percentile breakpoint. For instance, the long-only portfolios are formed using stocks that registered a factor reading below the median value for small-size portfolios. Alternatively, stocks with readings smaller than the 70th percentile provided the second option for forming size factor long-only portfolios. Like the case in the zero-cost portfolios, portfolios formed according to the median breakpoint provided much better performance in capturing pockets of mispricings.

3.5 130/30 long-short alternative strategy portfolios

We decided to construct 130/30 long-short portfolios for factor investing risk factors and test whether we can enhance Jensen's alphas' statistical significance and magnitude for some underperforming factors. The factors that performed well in zero-cost portfolio returns were expected to show considerable improvement under the 130/30 scheme. We also expect to see some borderline performances of positive alpha factors that were very close to becoming statistically significant to improve and become statistically significant under the 130/30 scheme. In this investment strategy, the numbers “130” and “30” indicate a 130% weighting in long positions and a 30% in short positions within the same portfolio.

Under this strategy, an asset manager who anticipates that a group of stocks will outperform the market will go 130% long on these securities and short sell 30% of stocks that he thinks will underperform the market. He initially purchases TL 100 worth of stocks that he thinks will outperform the market and then short TL 30 worth of stocks that he thinks will underperform the market. He then uses the short sale proceeds to buy TL 30 more of the stocks that he thinks will outperform the market.

At the end of these transactions, his total exposure will be TL 160, and his net long position will be TL 100.

The 130/30 portfolios are designed to have a beta of one. Hence, the 130/30 portfolio is structured such that the targeted net portfolio beta is the same beta value as that of the market. As the newly constructed 130/30 portfolio will have the same systematic risk as to the market, it is expected that this strategy will deliver positive alpha without incurring additional market risk.

3.6 The holding period return calculations

The portfolio construction process incorporated the holding period return assumption, where portfolio returns included dividends and capital gains. All dividend income received from a stock was assumed to be reinvested throughout the holding periods in the shares of the same dividend distributing firm. Other corporate actions and events like M&A transactions, squeeze-outs, spin-offs, and delistings due to bankruptcies are also reflected in portfolio returns. The holding period stock returns of all the listed companies are represented throughout the study until an eventual delisting occurs due to bankruptcy or a squeeze-out. Bankruptcy events are registered as a loss in the relevant portfolio, while proceeds from a squeeze-out event are reinvested pro-rata among its relevant portfolio.

The use of total return data, which incorporates dividend reinvestments in the return calculations, plays a vital role in this empirical study. Dividend reinvestments present a fair comparison between dividend-paying firms and their income retaining counterparts by indirectly equating the holding period returns of these firms. Firms that retain the distributable income for internal use can reinvest the funds otherwise reserved for cash dividends into other business opportunities and reflect those

opportunities in the form of capital gains to the investors. On the other hand, dividend-paying firms pay dividends to give the investors an option to reinvest in the same opportunity set. Hence, although not the best remedy, using a dividend reinvestment adjustment in the return calculations effectively addresses a significant portion of the comparability problem and helps eliminate an unwarranted bias in favor of non-dividend-paying firms.

3.6.1 Adjustments for corporate actions

3.6.1.1 Cash dividends

The total return approach in portfolio construction considers the impact of dividend distributions by reinvesting the dividends in the company's stock that initially issued the dividends. By design, the concept of "Total Return" results from reinvesting all dividends paid by the portfolio constituents back into the portfolio in question. Although the contribution of dividends to the total return performance may not be visible in the short run, the difference in accumulated wealth is significant in the long run due to the reinvestment of income. When a company declares a dividend, the equity's share price drops in the exact amount of the per-share dividend amount at the dividend payment date. Hence the direct impact of a dividend upon a price index is a drop in the index readings. On the contrary, the total return indexes are adjusted to reflect the dividend reinvestments. Likewise, the portfolios used in this study were adjusted for the issuance of dividends and subsequent reinvestments.

In our calculations, gross dividends are used instead of net dividends (dividends net of withholding tax) due to changing taxation practices.

3.6.1.2 Exercising of pre-emptive rights on common stock

Another critical adjustment in our time series total return data is for capital increases. The periods when firms tap additional equity financing through rights issues distort the price index data by unnecessarily inflating the index values and creating an illusion of a return. In order to overcome this misrepresentation, we subtract the capital infusion from MCAP data to neutralize its impact on index readings. As represented in the total return calculation methodology section, it is required that all the cash inlets and outlays are taken into account. Hence all rights issues and dividend payments are accounted for throughout this study.

A further critical point in the total return calculation was the information on the exercise price of the pre-emptive rights. The exact exercise price must be known to calculate the impact of the rights issue on the market capitalization of the related firm. In this study, this critical detail was also taken into account.

3.6.1.3 Stock splits-(stock dividends and bonus shares)

No adjustments are necessary in the case of stock splits, be it in the form of stock dividends or bonus shares, as they have no impact on market capitalization.

3.6.1.4 Mergers-(acquirer and target are both listed companies)

In the case of mergers where the acquirer and the target are both listed companies, the conversion ratio in shares becomes the most critical factor. As the process requires the delisting of the target company, a rebalance is required in the relevant portfolio containing the target's shares by exchanging those with the acquirer's shares. There has been no merger on a cash basis where the target firm's shareholders were entitled to receive cash in return for their shares in the target

company. However, if the transaction is in cash, in part, or in full, the cash amount should be distributed within the relevant portfolio in the corresponding period.

From the perspective of the acquirer's shareholders, if the merger transaction is carried out in the form of the acquirer's stock, then the value of the merger transaction should be deducted from the ex-post MCAP of the acquirer. Appendix A shows a typical stock exchange announcement regarding a merger, where both the acquiring party and the target are listed.

3.6.1.5 Mergers-(acquirer is a listed company, but the target is an unlisted one)

Suppose the acquirer is a listed company, whereas the target is an unlisted one. In that case, there remain two options. There will either be a rights issue where the pre-emptive rights of the existing shareholders are suspended, and the transaction is carried out in the form of the acquirer's stock, or there is a cash settlement in part or whole. If the settlement contains shares of the acquirer, the total value of the rights issue (the merged entity) should be deducted from the ex-post MCAP of the acquirer. In the case of cash settlement, no adjustment is required. Appendix B shows a typical company announcement regarding a merger, where the acquiring party is a listed company, but the target is an unlisted one.

3.6.1.6 Mergers-(acquirer is an unlisted company, but the target is a listed one)

If the merged entity aims to become a listed company, the listed-(in this case, the target) company's shareholders will receive the acquirer's shares in return for their existing shares. This action needs no adjustment other than a stock symbol and name change. However, if the acquirer wishes to stay unlisted, the target's shareholders will use their exit rights and be paid in cash in return for their shares. In that case a

rebalance in the relevant portfolio is required. Appendix C shows a typical stock exchange announcement regarding a merger where the acquiring party is an unlisted company but the target is a listed one.

3.6.1.7 Squeeze-out/sell-out or use of exit rights

According to Capital Markets Law-(CML), majority shareholders in a public company have squeeze-out rights within the timeframe as prescribed in the relevant communique of the Capital Markets Board-(CMB). The majority shareholders may require the listed company to nullify shares held by minority shareholders and issue new shares representing the capital held by minority shareholders to enable the purchase of such shares by the majority shareholders. In contrast, minority shareholders also have a sell-out right and, within the timeframes as prescribed in the relevant communique of the CMB, request the majority shareholders to purchase their shares in exchange for a fair value. In the case of squeeze-out or sell-out, there needs to be a rebalancing in the relevant portfolios. The squeeze-out or sell-out proceeds should be distributed within the relevant portfolio in the corresponding period.

According to CML, shareholders have the right to sell their shares directly to the public company to which they are shareholders under the “Exit Right” scheme. This scheme is applicable in the event a public company makes critical decisions. Merger and de-merger transactions, type conversions, decisions to dissolve or delisting, transfer of all or a material portion of the firm's assets are among these critical decisions. delisting decisions are considered among those critical decisions. Shareholders participating in the general assembly resolutions where the abovementioned transactions are discussed, who cast negative votes and record their

objections in the meeting minutes may exit the company by selling their shares to the public company. Like the case in squeeze-out or sell-out, usage of exit rights necessitates a rebalancing in the relevant portfolios. The proceeds from the exit rights should be distributed within the relevant portfolio in the corresponding period. Appendix D shows an example of a typical company declaration regarding a squeeze-out transaction.

3.6.2 Stock symbol (ticker symbol) and name changes

Depending on the type of the corporate action and its effects on the public company's financials, code or name changes are either neglected or treated as a separate entity. In the former case, the latest stock symbol, which appeared on 30 June 2019, was used throughout the study. In the latter case, the new entity will be treated as a newly listed merger, and a rebalance is required in the relevant portfolios regarding the conversion ratio of shares, as depicted in the case of a merger.

3.6.3 Share classes

Several listed companies have different share classes where voting, dividend, and liquidation rights may differ. This study will collect data regarding all share classes under a single entity, and therefore all rankings will be based on data provided for this synthetically produced single entity. Table 2 shows the list of firms having listed share classes.

Table 2. The Share Classes

Company Name	Stock Symbol for Share Classes
ADANA ÇİMENTO SANAYİİ T.A.Ş.	
	ADANA
	ADBGR
	ADNAC
CARREFOURSA CARREFOUR SABANCI TİCARET MERKEZİ A.Ş.	
	CARFA-(Code changed to CRFSA on 07.08.2015)
	CARFB-(Code changed to CRFSA on 07.08.2015)
TÜRKİYE İŞ BANKASI A.Ş.	
	ISATR
	ISBTR
	ISCTR
	ISKUR
KARDEMİR KARABÜK DEMİR ÇELİK SANAYİ VE TİCARET A.Ş.	
	KRDMA
	KRDMB
	KRDMD
MENSA SINAİ TİCARİ VE MALİ YATIRIMLAR A.Ş.	
	MEMSA
	MEMS1

3.6.4 The total return calculation

A total return index reading is calculated for every month-end for each stock using the below formula;

$$MCAP_{it} = P_{it}[NOS_{it-1} + SS_{it} + R_{it}] \quad (11)$$

$$TRI_{it} = \frac{[MCAP_{it} - (P_{rit}R_{it}) - MCAP_{met} + D_{it}]}{MCAP_{it-1}} \quad (12)$$

where;

TRI_{it} = Total return index for stock i at time t.

$MCAP_{it}$ = Total market capitalization of stock i at time t.

$MCAP_{it-1}$ = Total market capitalization of stock i at time (t – 1).

$MCAP_{met}$ = Total market capitalization of the merged entity at time t.

NOS_{it-1} = Number of outstanding shares of stock i at time (t – 1).

P_{it} = Price per share for stock i at time t.

SS_{it} = Number of shares issued in stock splits or stock dividends for stock i at time t.

R_{it} = Number of Shares issued for the Rights Issue for stock i at time t.

P_{rit} = Price of a rights issue for stock i at time t.

D_{it} = Gross cash dividends for stock i paid at time t.

A monthly total return percentage is calculated for each stock for every month using the above formula. Gross cash dividends are deemed to be reinvested at the ex-dividend date.

We assume that all ex-dividend dates are deemed to occur at month-ends as we use monthly frequency in our data.

3.7 The market proxy problem

We use a total return holding period calculation methodology for risk factor portfolio returns. A direct consequence of this choice was to select a reference market portfolio bearing the same return characteristics. We, therefore, looked for a total return market proxy to eliminate an inherent design characteristic of stock price indices; they typically tend to deflate in value during corporate dividend payout sprees. Thus against this backdrop, the primary market proxy in this study is selected to be BIST-All Share Total Return Price Index-(XUTUM_CFNNTLTL). However,

as the BIST-All Share Total Return Price Index series is only available through 31 October 2000, custom monthly total return index readings have been calculated and used for the earlier periods. XU100 Price index was used interchangeably as the reference market portfolio for further sensitivity analysis. Although using a total return price index as the reference market portfolio is a sensible choice from the perspective of the CAPM theory, the bulk of the past academic analyses on the Turkish equity market used the BIST-100-(XU100) Price Index as the market proxy. Perhaps this is due to the unavailability of a total return price index series overlapping the domain of the research period of those studies. We assert that using a price index as the reference market portfolio in CAPM tests is misleading. A price index market proxy is not only capable of distorting statistical significance by delivering overly optimistic test results, but it also distorts the observed Jensen's alpha potential of risk factors by an oversized alpha. To further elaborate on the stark differences in results between the two approaches, the same analysis was replicated using two different index series-(XU100-BIST price index and the total return index; XUTUM_CFNNTLTL) representing two different reference market portfolios.

3.8 Risk-free rate

In this study, we tried to select the best possible proxy for risk-free rate as a one-month return index for Turkish T-Bills does not exist apart from a brief period. TKYD-(Turkish Institutional Investment Managers' Association) published a time-series return index for one-month T-Bills between 31 January 2002 and 31 May 2012. We tried to find the best alternative that mimics the return dynamics of one-month T-Bills. The best proxy for one-month T-Bills returns data turned out to be KYD O/N Repo Indices which are now calculated and published by the Borsa

Istanbul administration. The BIST-KYD Repo Indices are calculated in two different types to monitor gross and net repo returns of overnight repo transactions in DSM Repo-Reverse Repo Market.

We selected BIST-KYD Gross-Repo Index as a proxy for the risk-free rate. However, the index only started on 31 January 2003. Therefore, we used the daily market return data regarding reverse repo transactions published by the Istanbul Stock Exchange (ISE) as the risk-free rate proxy from 31 December 1993 until 31 January 2003. Finally, for the brief remaining period between 31 December 1991 and 31 December 1993, we used TCMB-(Turkish Central Bank) data on daily Interbank interest rates as a proxy for the risk-free rate. We, therefore, combined the three time-series rate of return data to form a single time-series data to serve as the risk-free rate data to be used throughout the study.

CHAPTER 4

DATA HANDLING

4.1 Data source and scope of analysis

The number of listed companies covered under this study comprises all the listings on the Turkish stock market starting as early as 3 January 1986. Including the boost emanating from changes in codes and names due to mergers and acquisitions and different share classes, the number of listed stocks-(including different share classes) from 3 January 1986 onwards until 30 June 2019 was totaled 617. In the same period, the number of listed companies-(including name changes and delistings) was 608. Out of this sample, we have excluded listed Investment Trusts and ETFs from our study as managed securities portfolios and index replications are not in our domain. Hence, excluding Investment Trusts and ETFs, all stocks that have a listing in the past are represented in this analysis, provided that there is end-of-year financial data and at least 24-month price data.

All financial and monthly stock price data were procured from FINNET (a prominent and reputable data vendor that markets secondary financial data). The monthly secondary data that incorporate stock prices, corporate actions, and year-end financial figures have been selected to cover 1 January 1991 to 30 June 2019. A portfolio has been formed for each risk factor, which was rebalanced every 12 months starting from 30 June 1992. A six-month gap was kept between every year-end to construct the portfolios to ensure that the end-of-year financial information for all stocks is readily available and accessible for all investors. Hence, the end-of-June 12-month portfolio rebalancing period realistically reflects the real-life setting and flow of public financial information.

We have decided to partition the holding periods to analyze different periods with their sharply contrasting economic backdrops. Hence, for further refinement, the study has been partitioned into two periods, i.e., July 1992 to June 2002 and July 2002 to June 2019, to contrast the undercapitalization period of the ’90s, mainly characterized by boom and bust cycles. The heavily corrupted political system of the 90s and a virtually bankrupt banking sector brought havoc into the markets with some skyrocketing real interest rates. This period has been plagued with foreign currency crises and little or no interest from international institutional investors. The large-scale banking bankruptcies in 2001 and the following ground-up rehabilitation of the Turkish banking system paved the way to a booming period. The global economic backdrop was also highly supportive due to the expansionary monetary policies of the FED. The ECB later replicated these expansionary measures, which helped further boost international portfolio investments. The associated low-interest environment that created a global hunt for yield increased the importance of emerging markets like Turkey. Thus, Turkey became an emerging market hot spot with its new economic agenda shaped by its EU accession process and the aggressive privatization program. The ample international funding and a renewed foreign interest in Turkish capital markets marked this era until a new wave of political corruption and economic instability again plagued the Turkish markets.

The return data were tested for their stationarity using the Augmented Dickey-Fuller Model-2 (Constant and Trend) test for statistical viability. Table 3 shows the t statisticss for the fundamental indexation and factor investing risk factor porfolios’ monthly returns. All time-series return data used in the study was tested and found to be stationary and hence statistically suitable for use.

Table 3. Augmented Dickey Fuller Test - Model 2 (Constant and Trend)

Augm. Dickey Fuller t Statistics	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Fundamental Indexation			
Book Value	-5.765	-8.222	-9.528
Trailing Five-year Avg. Net Sales	-5.758	-8.080	-9.480
Trailing Five-year Avg. Gross Dividends	-5.675	-8.414	-9.639
Trailing Five-year Avg. Cash Flow	-5.647	-8.190	-9.471
Composite-AHM	-5.700	-8.112	-9.473
Factor Investing - Long Only-Median Breakpoint			
Book to Price-Value	-5.731	-7.928	-9.318
Net Earnings to Price-Value	-5.659	-7.502	-9.300
EBIT-DA-Value	-5.780	-8.518	-9.818
Total MCAP-Small Size	-5.643	-7.516	-9.213
Free Float MCAP-Small Size	-5.887	-7.790	-9.591
Standard Deviation-Low Volatility	-5.646	-7.506	-9.329
Beta-Low Volatility	-5.850	-7.985	-9.580
Gross Dividend Yield-High Yield	-5.438	-7.882	-9.333
ROE-Quality	-5.731	-7.162	-9.288
Trailing Five-year Avg. Earnings Growth-Quality	-5.853	-8.125	-9.708
Financial Leverage-Quality	-5.942	-8.099	-9.780
Momentum-Momentum	-6.073	-8.571	-10.073
Composite-Value	-5.723	-7.949	-9.453
Composite-Low Size	-5.773	-7.640	-9.399
Composite-Low Volatility	-5.709	-7.683	-9.396
Composite-High Yield	-5.438	-7.882	-9.333
Composite-Quality	-5.875	-7.927	-9.664
Composite-Momentum	-6.073	-8.571	-10.073
Composite-All Factors	-5.698	-7.874	-9.425
Factor Investing - Long Only-30th Percentile Breakpoint			
Book to Price-Value	-5.758	-7.984	-9.392
Net Earnings to Price-Value	-5.641	-7.559	-9.298
EBIT-DA-Value	-5.821	-8.596	-9.912
Total MCAP-Small Size	-5.974	-8.055	-9.705
Free Float MCAP-Small Size	-5.929	-7.957	-9.590
Standard Deviation-Low Volatility	-5.444	-7.293	-9.055
Beta-Low Volatility	-6.027	-8.798	-10.162
Gross Dividend Yield-High Yield	-5.425	-7.934	-9.332
ROE-Quality	-5.640	-7.117	-9.187
Trailing Five-year Avg. Earnings Growth-Quality	-5.870	-8.164	-9.721
Financial Leverage-Quality	-5.942	-8.109	-9.777

Table 3. Augmented Dickey Fuller Test - Model 2 (Constant and Trend)

Augm. Dickey Fuller t Statistics	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Momentum-Momentum	-6.219	-8.417	-10.279
Composite-Value	-5.734	-7.974	-9.484
Composite-Small Size	-5.937	-8.000	-9.621
Composite-Low Volatility	-5.693	-7.977	-9.513
Composite-High Yield	-5.425	-7.934	-9.332
Composite-Quality	-5.886	-7.927	-9.670
Composite-Momentum	-6.219	-8.417	-10.279
Composite-All Factors	-5.725	-7.970	-9.479
Sample Size	120	204	324
ADF-Constant and Trend Critical Values ($p<0.05$)	3.452	3.452	3.427

4.2 Control for survivorship and delisting bias

All stocks either have a current listing or were listed in the past but already delisted on the Istanbul Stock Exchange (later renamed Borsa Istanbul) were represented in this analysis. The only requirement for inclusion was the existence of at least 24-month price data and the prior year's financial statements. Any delistings or code changes due to mergers and acquisitions, liquidation, or squeeze-out actions were accounted for and represented in the data handling. Delistings due to liquidation were treated as outright losses, whereas squeeze-outs and mergers and acquisitions require either rebalancing or code changes within the relative portfolio. Hence, survivorship bias was totally eliminated as stock returns are represented throughout the study until an eventual delisting occurs due to bankruptcy or a squeeze-out event. As noted before, bankruptcy events are registered as a loss in the relevant portfolio, while proceeds from a squeeze-out event are reinvested pro-rata among its relevant portfolio.

CHAPTER 5

THE EMPIRICAL FINDINGS

5.1 Fundamental indexation portfolio returns

Table 4 shows the annual arithmetic and geometric returns of fundamental indexation portfolios. The annual geometric returns of factor portfolios and the composite portfolio are all significantly higher than the return for reference market portfolio-XUTUM_CFNNTLTL and the return for BIST-100 index in the analysis period of June 1993-June 2019 as well as in the two sub-periods. However, when comparing the annual geometric returns with the risk-free rate, the picture becomes gloomy, especially in the sub-period of June 1993-June 2002. The annual geometric returns on the entire analysis period of June 1993-June 2019 also take their toll due to the spillover effect from the earlier sub-period of June 1993-June 2002. The sub-period of June 2003-June 2019, on the other hand, provided the most robust annual geometric return performance as compared to the rest of the analysis periods. During this sub-period, annual geometric risk factor portfolio returns are considerably above the return for reference market portfolio-XUTUM_CFNNTLTL, the return for BIST-100, and the return for the risk-free rate.

Table 4. Annual Returns of Fundamental Indexation-AHM Methodology Risk Factor Portfolios

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book Value			
Avg. Annual Arithmetic Return	123.45%	22.57%	59.93%
Standard Deviation	102.13%	25.20%	80.41%
Annual Geometric Return	98.68%	20.15%	44.76%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	95,862.54	2,267.05	2,173,254.44

Table 4. Annual Returns of Fundamental Indexation-AHM Methodology Risk Factor Portfolios

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Trailing Five-year Average Net Sales			
Avg. Annual Arithmetic Return	123.83%	23.99%	60.97%
Standard Deviation	96.79%	23.42%	77.42%
Annual Geometric Return	100.30%	21.90%	46.51%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	103,924.17	2,895.82	3,009,455.94
Trailing Five-year Average Gross Dividends			
Avg. Annual Arithmetic Return	114.39%	26.98%	59.35%
Standard Deviation	91.98%	32.02%	73.55%
Annual Geometric Return	93.98%	23.55%	46.02%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	75,449.64	3,641.46	2,747,469.63
Trailing Five-year Average Cash Flow			
Avg. Annual Arithmetic Return	106.56%	23.83%	54.47%
Standard Deviation	92.39%	23.09%	70.29%
Annual Geometric Return	85.02%	21.75%	42.16%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	46,999.63	2,838.85	1,334,247.87
Composite-AHM			
Avg. Annual Arithmetic Return	117.19%	24.44%	58.79%
Standard Deviation	92.99%	25.40%	73.98%
Annual Geometric Return	95.25%	22.04%	45.24%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	80,536.29	2,953.06	2,378,285.32
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Return	95.48%	19.85%	47.86%
Standard Deviation	78.60%	23.33%	62.12%
Annual Geometric Return	78.18%	17.73%	37.26%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
BIST-100			
Avg. Annual Arithmetic Return	87.65%	16.93%	43.12%
Standard Deviation	77.00%	23.68%	60.07%
Annual Geometric Return	70.93%	14.70%	32.96%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51

Table 4. Annual Returns of Fundamental Indexation-AHM Methodology Risk Factor Portfolios

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
R_f - Risk-Free Rate			
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

5.2 Factor investing portfolio returns

Factor investing portfolios were constructed using two separate breakpoints; the median value of the factor readings and the 30th (or 70th according to the ranking order) percentile of the factor readings. The empirical findings regarding these two separate groups showed very little difference among the return characteristics of the two approaches. We can only assert that "small size" risk factors performed slightly better under the 30th percentile breakpoint, and median breakpoint portfolios have a slightly better overall return performance.

5.2.1 Return of factor investing portfolios constructed according to the median breakpoint

Table 5 shows the annual arithmetic and geometric returns of long-only factor investing portfolios constructed with a median breakpoint. The majority of annual geometric returns of factor portfolios and the composite portfolio are significantly higher than the return for reference market portfolio-XUTUM_CFNNTLTL and the return for the BIST-100 index. However, similar to the fundamental indexation example, the annual geometric returns underperformed relative to the risk-free rate, especially in the sub-period of June 1993-June 2002. In this sub-period, only "Book-

to-Price” and “Gross Dividend Yield” risk factors yielded a very close, but still lower, annual geometric return as compared to the return for the risk-free rate. Apart from a few exceptional cases like “Gross Dividend Yield," “Book-to-Price," and “Net Earnings to Price," the annual geometric returns on the entire analysis period of June 1993-June 2019 also suffer from the ripple effects of the earlier sub-period of June 1993-June 2002 similar to the findings in the fundamental indexation. The sub-period of June 2003-June 2019, on the other hand, provided the most robust annual geometric return performance as compared to the other analysis periods. The majority of annual geometric average risk factor portfolio returns are considerably above the return for reference market portfolio-XUTUM_CFNNTLTL, the return for BIST-100, and the return for the risk-free rate. There are also some stellar performances in this sub-period, even overshadowing the performances of fundamental indexation risk factors in the same sub-period. In the order of performance, “Gross Dividend Yield," "Net Earnings to Price," "Book to Price," and “Standard Deviation” have all registered a much higher geometric return than their factor investing and fundamental indexation risk factor counterparts.

From a long-short factor investing perspective, the median breakpoint long-short-(zero cost) portfolios are much more somber than the long-only factor investing strategies. Perhaps we can call the long-short strategy "Factor Neutral”-(as we can refer to market-neutral strategies) to neutralize the factor risk while trying to attain an absolute portfolio return. In order to become a viable investment alternative as compared to long-only portfolios, long-short factor investing portfolios should provide a holding period return much higher than that of the holding period return of the risk-free rate. Here we can make an analogy to Black’s zero beta factor. The zero beta factor is a portfolio with zero covariance with the return on the market portfolio

and hence bears no market risk. Therefore, the zero beta factor bears the same characteristic of a risk-free portfolio of securities. Hence, if we can eliminate market risk via a market-neutral strategy, the portfolio return should be greater than the risk-free rate of return to differentiate itself from a portfolio of risk-free securities. Another reason for this condition to hold is the existence of market imperfections in the form of the borrowing costs associated with the short sale. Hence, a market-neutral strategy should at least provide enough return to cover the borrowing costs of the short sale, and its return should be greater than the risk-free rate of return.

According to our findings, not a single factor investing long-short-(zero cost) median breakpoint portfolio has shown a return performance beating the risk-free rate of return in the entire analysis period, including the sub-periods.

Table 5. Annual Returns of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book to Price-Value			
Avg. Annual Arithmetic Return	154.62%	26.83%	74.16%
Standard Deviation	153.44%	24.09%	111.63%
Annual Geometric Return	111.21%	24.64%	51.53%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	176,664.86	4,227.51	7,468,529.99
Zero-Cost Port.Ret. Index Value-End	386.64	149.54	578.19
Net Earnings to Price-Value			
Avg. Annual Arithmetic Return	123.78%	27.80%	63.35%
Standard Deviation	118.06%	25.30%	86.31%
Annual Geometric Return	94.31%	25.40%	47.48%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	76,713.55	4,691.01	3,598,641.75
Zero-Cost Port.Ret. Index Value-End	188.06	172.77	324.91
EBIT-DA-Value			
Avg. Annual Arithmetic Return	96.91%	22.62%	50.13%
Standard Deviation	85.93%	22.13%	64.76%

Table 5. Annual Returns of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Annual Geometric Return	77.88%	20.69%	39.33%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	31,714.74	2,445.45	775,569.43
Zero-Cost Port.Ret. Index Value-End	15.76	68.61	10.82
Total MCAP-Small Size			
Avg. Annual Arithmetic Return	126.29%	19.94%	59.33%
Standard Deviation	125.73%	22.58%	92.33%
Annual Geometric Return	93.33%	17.99%	41.67%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	72,942.11	1,665.80	1,215,066.88
Zero-Cost Port.Ret. Index Value-End	62.18	71.88	44.69
Free Float MCAP-Small Size			
Avg. Annual Arithmetic Return	124.09%	22.14%	59.90%
Standard Deviation	123.91%	21.33%	90.06%
Annual Geometric Return	92.60%	20.43%	43.31%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	70,248.04	2,357.44	1,656,055.36
Zero-Cost Port.Ret. Index Value-End	85.20	100.01	85.20
Standard Deviation-Low Volatility			
Avg. Annual Arithmetic Return	107.58%	26.70%	56.65%
Standard Deviation	101.06%	25.62%	74.32%
Annual Geometric Return	84.10%	24.18%	43.68%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	44,726.30	3,970.23	1,775,736.55
Zero-Cost Port.Ret. Index Value-End	-0.51	252.10	-1.28
Beta-Low Volatility			
Avg. Annual Arithmetic Return	113.60%	20.52%	54.99%
Standard Deviation	94.54%	19.45%	73.65%
Annual Geometric Return	93.77%	19.05%	42.58%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	74,623.03	1,936.91	1,445,378.92
Zero-Cost Port.Ret. Index Value-End	41.93	67.71	28.39
Gross Dividend Yield-High Yield			
Avg. Annual Arithmetic Return	136.75%	33.66%	71.84%

Table 5. Annual Returns of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Standard Deviation	122.50%	34.89%	92.29%
Annual Geometric Return	106.27%	30.15%	54.36%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	139,458.17	8,823.00	12,304,390.58
Zero-Cost Port.Ret. Index Value-End	320.00	316.05	1,011.38
ROE-Quality			
Avg. Annual Arithmetic Return	107.77%	14.34%	8.83%
Standard Deviation	96.56%	41.47%	49.61%
Annual Geometric Return	86.02%	9.36%	-2.59%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	49,625.29	457.39	49.24
Zero-Cost Port.Ret. Index Value-End	39.36	116.91	46.02
Trailing Five-year Average Earnings Growth-Quality			
Avg. Annual Arithmetic Return	78.04%	14.15%	37.81%
Standard Deviation	104.56%	22.71%	71.35%
Annual Geometric Return	48.95%	11.76%	24.31%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	5,375.48	662.10	35,590.85
Zero-Cost Port.Ret. Index Value-End	14.10	16.39	2.31
Financial Leverage-Quality			
Avg. Annual Arithmetic Return	113.82%	19.82%	54.63%
Standard Deviation	86.73%	23.70%	71.34%
Annual Geometric Return	94.92%	17.60%	41.80%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	79,171.53	1,573.47	1,245,740.39
Zero-Cost Port.Ret. Index Value-End	60.52	67.11	40.61
Momentum-Momentum			
Avg. Annual Arithmetic Return	103.33%	19.78%	50.72%
Standard Deviation	87.73%	19.67%	67.77%
Annual Geometric Return	83.92%	18.21%	39.23%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	44,278.62	1,717.29	760,390.76
Zero-Cost Port.Ret. Index Value-End	25.47	88.55	22.55

Table 5. Annual Returns of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Composite-Value			
Avg. Annual Arithmetic Return	125.09%	25.89%	62.63%
Standard Deviation	115.74%	22.10%	85.56%
Annual Geometric Return	96.01%	24.01%	46.93%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	83,728.14	3,879.36	3,248,111.78
Zero-Cost Port.Ret. Index Value-End	144.42	134.52	194.27
Composite-Small Size			
Avg. Annual Arithmetic Return	128.40%	21.06%	60.81%
Standard Deviation	130.51%	21.83%	94.76%
Annual Geometric Return	94.62%	19.25%	42.97%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	77,968.64	1,994.13	1,554,797.38
Zero-Cost Port.Ret. Index Value-End	83.80	85.63	71.75
Composite-Low Volatility			
Avg. Annual Arithmetic Return	111.13%	23.57%	56.00%
Standard Deviation	96.91%	21.44%	73.42%
Annual Geometric Return	89.72%	21.77%	43.50%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	60,410.02	2,845.68	1,719,073.27
Zero-Cost Port.Ret. Index Value-End	17.35	145.90	25.31
Composite-High Yield			
Avg. Annual Arithmetic Return	136.75%	33.66%	71.84%
Standard Deviation	122.50%	34.89%	92.29%
Annual Geometric Return	106.27%	30.15%	54.36%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	139,458.17	8,823.00	12,304,390.58
Zero-Cost Port.Ret. Index Value-End	320.00	316.05	1,011.38
Composite-Quality			
Avg. Annual Arithmetic Return	103.21%	21.22%	51.59%
Standard Deviation	93.77%	19.73%	70.08%
Annual Geometric Return	81.12%	19.67%	39.52%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	37,992.31	2,116.66	804,166.57
Zero-Cost Port.Ret. Index Value-End	56.15	63.09	35.42

Table 5. Annual Returns of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Composite-Momentum			
Avg. Annual Arithmetic Return	103.33%	19.78%	50.72%
Standard Deviation	87.73%	19.67%	67.77%
Annual Geometric Return	83.92%	18.21%	39.23%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	44,278.62	1,717.29	760,390.76
Zero-Cost Port.Ret. Index Value-End	25.47	88.55	22.55
Composite-All Factors			
Avg. Annual Arithmetic Return	118.66%	24.22%	59.20%
Standard Deviation	104.06%	21.14%	78.63%
Annual Geometric Return	93.93%	22.56%	45.27%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	75,240.10	3,177.29	2,390,599.33
Zero-Cost Port.Ret. Index Value-End	92.41	135.98	125.65
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Return	95.48%	19.85%	47.86%
Standard Deviation	78.60%	23.33%	62.12%
Annual Geometric Return	78.18%	17.73%	37.26%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
BIST-100			
Avg. Annual Arithmetic Return	87.65%	16.93%	43.12%
Standard Deviation	77.00%	23.68%	60.07%
Annual Geometric Return	70.93%	14.70%	32.96%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51
R_f - Risk-Free Rate			
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

5.2.2 Return of factor investing portfolios constructed according to the 30th percentile breakpoint

Table 6 shows the annual arithmetic and geometric returns of long-only factor investing portfolios constructed with a 30th percentile breakpoint. Like the median breakpoint factor investing portfolios, most annual geometric returns of factor and composite portfolios are significantly higher than the return for reference market portfolio-XUTUM_CFNNTLTL and the return for the BIST-100 index. However, similar to the fundamental indexation example, the annual geometric returns underperformed considerably relative to the risk-free rate, especially in the sub-period of June 1993-June 2002. In this sub-period, only the "Gross Dividend Yield" risk factor registered a return above the risk-free rate of return. In contrast, "Book-to-Price" and small-size risk factors yielded very close but lowered annual geometric returns than risk-free rate returns. Similar to our findings in the median breakpoint factor investing risk factors, apart from a few exceptional cases like "Gross Dividend Yield," "Book-to-Price," "Net Earnings to Price," and the two "small size" risk factors, the annual geometric returns on the entire analysis period of June 1993-June 2019, show the ripple effects of the earlier sub-period of June 1993-June 2002. The only difference was the relatively better return performance of the "small size" risk factors under the 30th percentile breakpoint. The sub-period of June 2003-June 2019, on the other hand, provided the most robust annual geometric return performance as compared to the other analysis periods. The majority of annual geometric average risk factor portfolio returns are considerably above the return for reference market portfolio-XUTUM_CFNNTLTL, the return for BIST-100, and the return for the risk-free rate. As in the case of median breakpoint factor investing risk portfolios, some stellar performances exist in this sub-period, even overshadowing the performances

of fundamental indexation risk factors in the same sub-period. In the order of performance, “Gross Dividend Yield," "Net Earnings to Price," "Book to Price," and “Standard Deviation” have all registered a much higher geometric return than their factor investing and fundamental indexation risk factor counterparts. Although 30th percentile breakpoint factor investing risk factors have generally registered a similar return performance to median breakpoint portfolios, “small size” risk factors seem to show relatively better performance under the 30th percentile breakpoint.

As in the case of median breakpoint long-short factor investing risk factor portfolios, the 30th percentile breakpoint long-short-(zero cost) portfolios provide a much more somber picture than the long-only factor investing strategies. Although individual risk factor performances sharply differ under the two different breakpoint schemes, the final verdict does not change. Similar to our findings in the long-short median breakpoint factor investing risk factors, no 30th percentile long-short risk factor portfolios have shown a return performance beating the risk-free rate of return in the entire analysis period, including the sub-periods.

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book to Price-Value			
Avg. Annual Arithmetic Return	148.85%	26.06%	71.54%
Standard Deviation	144.95%	25.11%	106.35%
Annual Geometric Return	108.36%	23.68%	50.03%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	154,199.66	3,706.16	5,714,890.53
Zero-Cost Port.Ret. Index Value-End	537.43	145.86	783.88
Net Earnings to Price-Value			
Avg. Annual Arithmetic Return	124.96%	26.94%	63.25%
Standard Deviation	119.57%	27.12%	87.91%
Annual Geometric Return	94.74%	24.11%	46.64%

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	78,436.49	3,931.32	3,083,589.89
Zero-Cost Port.Ret. Index Value-End	99.06	147.08	145.70
EBIT-DA-Value			
Avg. Annual Arithmetic Return	95.99%	22.07%	49.45%
Standard Deviation	83.91%	22.90%	63.90%
Annual Geometric Return	77.75%	19.99%	38.79%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	31,491.38	2,216.79	698,098.12
Zero-Cost Port.Ret. Index Value-End	8.70	78.52	6.83
Total MCAP-Small Size			
Avg. Annual Arithmetic Return	146.16%	21.56%	67.71%
Standard Deviation	157.46%	23.06%	112.56%
Annual Geometric Return	104.22%	19.46%	45.70%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	126,191.01	2,053.85	2,591,778.10
Zero-Cost Port.Ret. Index Value-End	93.10	84.66	78.82
Free Float MCAP-Small Size			
Avg. Annual Arithmetic Return	146.41%	24.00%	69.34%
Standard Deviation	148.75%	28.33%	108.54%
Annual Geometric Return	106.36%	20.99%	47.44%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	140,021.77	2,549.96	3,570,504.22
Zero-Cost Port.Ret. Index Value-End	140.48	102.54	144.05
Standard Deviation-Low Volatility			
Avg. Annual Arithmetic Return	99.65%	27.03%	53.92%
Standard Deviation	94.67%	26.14%	69.28%
Annual Geometric Return	79.49%	24.45%	42.53%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	34,697.62	4,122.67	1,430,469.87
Zero-Cost Port.Ret. Index Value-End	4.89	413.35	20.20
Beta-Low Volatility			
Avg. Annual Arithmetic Return	113.14%	21.97%	55.74%
Standard Deviation	85.11%	21.02%	69.23%

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Annual Geometric Return	96.62%	20.33%	44.33%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	86,342.60	2,325.01	2,007,469.89
Zero-Cost Port.Ret. Index Value-End	24.49	85.16	20.86
Gross Dividend Yield-High Yield			
Avg. Annual Arithmetic Return	136.60%	33.88%	71.93%
Standard Deviation	119.45%	37.40%	91.40%
Annual Geometric Return	119.45%	30.01%	54.40%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	143,134.19	8,661.73	12,397,902.48
Zero-Cost Port.Ret. Index Value-End	153.80	246.11	378.51
ROE-Quality			
Avg. Annual Arithmetic Return	104.89%	14.69%	8.48%
Standard Deviation	93.70%	45.70%	51.38%
Annual Geometric Return	84.32%	8.89%	-3.09%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	45,272.52	425.36	42.86
Zero-Cost Port.Ret. Index Value-End	34.97	66.51	23.26
Trailing Five-year Average Earnings Growth-Quality			
Avg. Annual Arithmetic Return	78.12%	13.41%	37.38%
Standard Deviation	104.73%	22.51%	71.57%
Annual Geometric Return	48.90%	11.04%	23.79%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	5,356.98	593.45	31,791.17
Zero-Cost Port.Ret. Index Value-End	0.67	13.96	0.09
Financial Leverage-Quality			
Avg. Annual Arithmetic Return	113.82%	20.21%	54.88%
Standard Deviation	86.73%	23.24%	71.12%
Annual Geometric Return	94.92%	18.09%	42.18%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	79,169.72	1,689.17	1,337,310.85
Zero-Cost Port.Ret. Index Value-End	35.25	100.74	35.51
Momentum-Momentum			

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Avg. Annual Arithmetic Return	100.49%	17.03%	47.94%
Standard Deviation	91.12%	18.13%	69.02%
Annual Geometric Return	80.59%	15.64%	36.39%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	36,896.81	1,181.75	436,027.46
Zero-Cost Port.Ret. Index Value-End	17.14	46.57	7.98
Composite-Value			
Avg. Annual Arithmetic Return	124.47%	25.26%	62.01%
Standard Deviation	112.87%	22.75%	84.33%
Annual Geometric Return	96.29%	23.22%	46.41%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	84,917.10	3,477.88	2,953,311.83
Zero-Cost Port.Ret. Index Value-End	117.14	141.14	165.33
Composite-Small Size			
Avg. Annual Arithmetic Return	146.67%	22.78%	68.67%
Standard Deviation	152.91%	25.28%	110.47%
Annual Geometric Return	105.85%	20.32%	46.79%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	136,590.34	2,320.75	3,169,925.10
Zero-Cost Port.Ret. Index Value-End	120.04	94.90	113.92
Composite-Low Volatility			
Avg. Annual Arithmetic Return	109.97%	24.43%	56.11%
Standard Deviation	90.84%	21.47%	70.09%
Annual Geometric Return	91.04%	22.66%	70.09%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	64,747.01	3,218.66	2,083,985.57
Zero-Cost Port.Ret. Index Value-End	17.82	223.54	39.84
Composite-High Yield			
Avg. Annual Arithmetic Return	136.60%	33.88%	71.93%
Standard Deviation	119.45%	37.40%	91.40%
Annual Geometric Return	106.81%	30.01%	54.40%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	143,134.19	8,661.73	12,397,902.48
Zero-Cost Port.Ret. Index Value-End	153.80	246.11	378.51

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Composite-Quality			
Avg. Annual Arithmetic Return	103.51%	21.15%	51.66%
Standard Deviation	94.57%	20.05%	70.61%
Annual Geometric Return	81.31%	19.56%	39.50%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	38,396.41	2,085.65	800,814.47
Zero-Cost Port.Ret. Index Value-End	40.29	60.61	24.42
Composite-Momentum			
Avg. Annual Arithmetic Return	100.49%	17.03%	47.94%
Standard Deviation	91.12%	18.13%	69.02%
Annual Geometric Return	80.59%	15.64%	36.39%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	36,896.81	1,181.75	436,027.46
Zero-Cost Port.Ret. Index Value-End	17.14	46.57	7.98
Composite-All Factors			
Avg. Annual Arithmetic Return	121.74%	24.07%	60.24%
Standard Deviation	106.27%	20.83%	80.54%
Annual Geometric Return	96.77%	22.43%	45.95%
Portfolio Return Index Value-Start	100.00	100.00	100.00
Portfolio Return Index Value-End	86,993.01	3,119.79	2,713,998.14
Zero-Cost Port.Ret. Index Value-End	85.39	139.85	119.42
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Return	95.48%	19.85%	47.86%
Standard Deviation	78.60%	23.33%	62.12%
Annual Geometric Return	78.18%	17.73%	37.26%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
BIST-100			
Avg. Annual Arithmetic Return	87.65%	16.93%	43.12%
Standard Deviation	77.00%	23.68%	60.07%
Annual Geometric Return	70.93%	14.70%	32.96%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51
R_f - Risk Free Rate			

Table 6. Annual Returns of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

5.3 Fundamental indexation portfolios' excess returns over the risk-free rate

Table 7 shows fundamental indexation portfolios' annual arithmetic and geometric excess returns. The annual geometric excess returns of factor portfolios and the composite portfolio are significantly higher than the excess return for reference market portfolio-XUTUM_CFNNTLTL and the excess return for BIST-100 index in the analysis period June 1993-June 2019 as well as in the two-sub-periods. The sub-period of June 1993-June 2002 was plagued with negative excess returns due to the adverse macroeconomic backdrop of this period. The annual geometric excess returns on the entire analysis period of June 1993-June 2019 also take their toll due to the spillover effect from the earlier sub-period of June 1993-June 2002. The sub-period of June 2003-June 2019, on the other hand, provided the most robust annual geometric excess return performance as compared to the rest of the analysis periods. During this sub-period, annual geometric portfolio excess returns are considerably above the return for reference market portfolio-XUTUM_CFNNTLTL and the return for BIST-100.

The annualized Sharpe ratios of the fundamental indexation portfolios are also considerably higher than the Sharpe ratios of the reference market portfolio-XUTUM_CFNNTLTL and BIST-100 in all analysis periods.

Table 7. Annual Excess Returns-(Portfolio Return - R_f) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book Value			
Avg. Annual Arithmetic Excess Return	5.25%	6.14%	5.81%
Standard Deviation	62.72%	21.78%	40.67%
Annual Geometric Excess Return	-14.40%	3.96%	-3.26%
Annualized Sharpe Ratio*	15.52%	27.88%	18.90%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	21.12	193.40	40.85
Trailing Five-year Average Net Sales			
Avg. Annual Arithmetic Excess Return	5.06%	7.50%	6.60%
Standard Deviation	59.12%	21.54%	38.69%
Annual Geometric Excess Return	-12.90%	5.48%	-1.74%
Annualized Sharpe Ratio*	15.88%	32.99%	20.87%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	25.12	247.59	62.20
Trailing Five-year Average Gross Dividends			
Avg. Annual Arithmetic Excess Return	1.49%	9.62%	6.61%
Standard Deviation	59.20%	25.41%	40.33%
Annual Geometric Excess Return	-15.63%	6.95%	-2.05%
Annualized Sharpe Ratio	8.86%	35.69%	19.58%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	18.27	313.20	57.24
Trailing Five-year Average Cash Flow			
Avg. Annual Arithmetic Excess Return	-2.26%	7.41%	3.83%
Standard Deviation	58.57%	21.38%	38.62%
Annual Geometric Excess Return	-20.06%	5.35%	-4.89%
Annualized Sharpe Ratio*	2.38%	32.83%	13.33%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	10.66	242.53	25.86
Composite-AHM			
Avg. Annual Arithmetic Excess Return	2.41%	7.75%	5.77%
Standard Deviation	58.42%	21.89%	38.51%
Annual Geometric Excess Return	-15.34%	5.61%	-2.69%
Annualized Sharpe Ratio*	10.87%	33.23%	18.48%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	18.92	252.90	47.85

Table 7. Annual Excess Returns-(Portfolio Return - R_f) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Excess Return	-7.87%	3.80%	-0.52%
Standard Deviation	51.04%	20.42%	34.52%
Annual Geometric Excess Return	-23.36%	1.84%	-8.34%
Annualized Sharpe Ratio*	-5.24%	20.63%	5.16%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
Excess Return Index Value-End	6.99	136.35	9.53
BIST-100			
Avg. Annual Arithmetic Excess Return	-11.45%	1.21%	-3.47%
Standard Deviation	50.22%	20.51%	34.21%
Annual Geometric Excess Return	-26.22%	-0.81%	-11.11%
Annualized Sharpe Ratio*	-11.48%	11.81%	-1.42%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51
Excess Return Index Value-End	4.78	87.02	4.16
R_f - Risk Free Rate			
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

Note: * Ex-post Sharpe Ratio (revised version) William F. Sharpe (1994).

5.4 Factor investing portfolios' excess returns over the risk-free rate

5.4.1 Excess return of factor investing portfolios over risk-free rate constructed according to the median breakpoint

Table 8 shows the annual arithmetic and geometric excess returns of long-only factor investing portfolios constructed with a median breakpoint. The majority of annual geometric excess returns of factor portfolios and composite portfolios are significantly higher than the excess return for reference market portfolio-XUTUM_CFNNTLTL and the excess return for BIST-100 index in the analysis period June 1993-June 2019 as well as in the two-sub-periods. The sub-period of June 1993-June 2002 was characterized by negative excess returns due to the adverse macroeconomic conditions of this period. The annual geometric excess returns on the entire analysis period of June 1993-June 2019 also take their toll due to the spillover effect from the earlier sub-period of June 1993-June 2002. The sub-period of June 2003-June 2019, on the other hand, provided the most robust annual geometric excess return performance as compared to the rest of the analysis periods. During this sub-period, annual geometric portfolio excess returns are considerably above the excess return for reference market portfolio-XUTUM_CFNNTLTL and the excess return for BIST-100. Best excess return performers in this sub-period were "Gross Dividend Yield," "Return on Equity-ROE," "Net Earnings to Price," "Book to Price," and "Standard Deviation ."They have all registered a much higher geometric return than their median breakpoint factor investing and fundamental indexation risk factor counterparts.

The annualized Sharpe ratios of the best performing median breakpoint factor investing portfolios are also considerably higher than the Sharpe ratios of the

reference market portfolio-XUTUM_CFNNTLTL and BIST-100 as well as their median breakpoint factor investing and fundamental indexation risk factor counterparts.

Table 8. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book to Price-Value			
Avg. Annual Arithmetic Excess Return	23.55%	10.08%	15.07%
Standard Deviation	94.49%	22.52%	58.71%
Annual Geometric Excess Return	-10.50%	7.89%	0.67%
Annualized Sharpe Ratio*	24.58%	42.66%	27.71%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	32.99	363.39	119.87
Net Earnings to Price-Value			
Avg. Annual Arithmetic Excess Return	8.19%	10.91%	9.90%
Standard Deviation	75.00%	23.50%	47.84%
Annual Geometric Excess Return	-17.48%	8.55%	-1.93%
Annualized Sharpe Ratio*	9.98%	42.47%	21.60%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	14.64	403.16	59.04
EBIT-DA-Value			
Avg. Annual Arithmetic Excess Return	-6.86%	6.25%	1.39%
Standard Deviation	55.31%	20.01%	36.70%
Annual Geometric Excess Return	-23.08%	4.42%	-6.76%
Annualized Sharpe Ratio*	-7.01%	29.46%	7.75%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	7.25	208.64	15.12
Total MCAP-Small Size			
Avg. Annual Arithmetic Excess Return	8.41%	4.08%	5.69%
Standard Deviation	77.05%	21.70%	48.47%
Annual Geometric Excess Return	-19.03%	2.06%	-6.33%
Annualized Sharpe Ratio*	10.67%	21.09%	13.17%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	12.11	141.39	17.12
Free Float MCAP-Small Size			

Table 8. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Avg. Annual Arithmetic Excess Return	7.46%	5.96%	6.52%
Standard Deviation	76.26%	20.68%	47.72%
Annual Geometric Excess Return	-19.26%	4.19%	-5.19%
Annualized Sharpe Ratio*	7.91%	29.03%	14.66%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	11.78	201.08	23.68
Standard Deviation-Low Volatility			
Avg. Annual Arithmetic Excess Return	-0.81%	9.73%	5.82%
Standard Deviation	65.35%	22.66%	42.68%
Annual Geometric Excess Return	-21.39%	7.50%	-4.27%
Annualized Sharpe Ratio*	-2.12%	40.72%	14.14%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	9.01	341.77	30.80
Beta-Low Volatility			
Avg. Annual Arithmetic Excess Return	1.63%	4.58%	3.48%
Standard Deviation	62.33%	18.79%	39.55%
Annual Geometric Excess Return	-15.81%	2.98%	-4.42%
Annualized Sharpe Ratio*	5.32%	24.49%	11.35%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	17.89	164.83	29.50
Gross Dividend Yield-High Yield			
Avg. Annual Arithmetic Excess Return	14.79%	15.42%	15.19%
Standard Deviation	79.07%	27.12%	51.16%
Annual Geometric Excess Return	-11.86%	12.73%	2.91%
Annualized Sharpe Ratio*	20.08%	52.60%	31.30%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	28.30	767.19	217.12
ROE-Quality			
Avg. Annual Arithmetic Excess Return	-0.54%	14.34%	8.83%
Standard Deviation	62.43%	41.47%	49.61%
Annual Geometric Excess Return	-19.98%	9.36%	-2.59%
Annualized Sharpe Ratio*	-0.69%	40.07%	19.11%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	10.77	457.39	49.24

Trailing Five-year

Table 8. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Average Earnings Growth-Quality			
Avg. Annual Arithmetic Excess Return	-19.85%	-1.05%	-8.01%
Standard Deviation	55.25%	21.63%	37.82%
Annual Geometric Excess Return	-38.32%	-3.42%	-18.20%
Annualized Sharpe Ratio*	-25.72%	4.72%	-11.90%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	0.80	55.38	0.44
Financial Leverage-Quality			
Avg. Annual Arithmetic Excess Return	-1.84%	3.68%	1.64%
Standard Deviation	50.41%	20.04%	33.68%
Annual Geometric Excess Return	-15.27%	1.72%	-4.94%
Annualized Sharpe Ratio*	17.34%	21.03%	16.84%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	19.06	133.53	25.46
Momentum-Momentum			
Avg. Annual Arithmetic Excess Return	-3.74%	3.84%	1.03%
Standard Deviation	54.81%	18.17%	35.45%
Annual Geometric Excess Return	-20.10%	2.25%	-6.67%
Annualized Sharpe Ratio*	0.24%	21.81%	8.17%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	10.61	146.02	15.49
Composite-Value			
Avg. Annual Arithmetic Excess Return	8.22%	9.19%	8.83%
Standard Deviation	73.19%	20.37%	45.93%
Annual Geometric Excess Return	-16.09%	7.34%	-2.02%
Annualized Sharpe Ratio*	10.06%	40.28%	19.90%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	17.30	333.14	57.62
Composite-Small Size			
Avg. Annual Arithmetic Excess Return	9.76%	5.04%	6.79%
Standard Deviation	79.57%	21.11%	49.71%
Annual Geometric Excess Return	-18.32%	3.16%	-5.39%
Annualized Sharpe Ratio*	9.51%	25.21%	14.16%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	13.21	169.71	22.42

Table 8. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Composite-Low Volatility			
Avg. Annual Arithmetic Excess Return	0.67%	7.13%	4.74%
Standard Deviation	63.43%	19.95%	40.59%
Annual Geometric Excess Return	-18.17%	5.38%	-4.04%
Annualized Sharpe Ratio*	1.56%	34.01%	12.99%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	13.46	243.74	32.80
Composite-High Yield			
Avg. Annual Arithmetic Excess Return	14.79%	15.42%	15.19%
Standard Deviation	79.07%	27.12%	51.16%
Annual Geometric Excess Return	-11.86%	12.73%	2.91%
Annualized Sharpe Ratio*	20.08%	52.60%	31.30%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	28.30	767.19	217.12
Composite-Quality			
Avg. Annual Arithmetic Excess Return	-6.00%	5.13%	1.01%
Standard Deviation	54.71%	18.62%	35.77%
Annual Geometric Excess Return	-22.32%	3.52%	-6.93%
Annualized Sharpe Ratio*	-2.69%	26.37%	8.93%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	8.00	179.93	14.39
Composite-Momentum			
Avg. Annual Arithmetic Excess Return	-3.74%	3.84%	1.03%
Standard Deviation	54.81%	18.17%	35.45%
Annual Geometric Excess Return	-20.10%	2.25%	-6.67%
Annualized Sharpe Ratio*	0.24%	21.81%	8.17%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	10.61	146.02	15.49
Composite-All Factors			
Avg. Annual Arithmetic Excess Return	4.21%	7.65%	6.37%
Standard Deviation	65.82%	18.85%	41.49%
Annual Geometric Excess Return	-16.75%	6.07%	-3.03%
Annualized Sharpe Ratio*	6.88%	35.97%	16.76%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	16.00	272.44	43.58

Table 8. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - Median Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Excess Return	-7.87%	3.80%	-0.52%
Standard Deviation	51.04%	20.42%	34.52%
Annual Geometric Excess Return	-23.36%	1.84%	-8.34%
Annualized Sharpe Ratio*	-5.24%	20.63%	5.16%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
Excess Return Index Value-End	6.99	136.35	9.53
BIST-100			
Avg. Annual Arithmetic Excess Return	-11.45%	1.21%	-3.47%
Standard Deviation	50.22%	20.51%	34.21%
Annual Geometric Excess Return	-26.22%	-0.81%	-11.11%
Annualized Sharpe Ratio*	-11.48%	11.81%	-1.42%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51
Excess Return Index Value-End	4.78	87.02	4.16
R_f - Risk Free Rate			
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

Note: * Ex-post Sharpe Ratio (revised version) William F. Sharpe (1994).

5.4.2 Excess return of factor investing portfolios over risk-free rate constructed according to the 30th percentile breakpoint

Table 9 shows the annual arithmetic and geometric excess returns of long-only factor investing portfolios constructed with a 30th percentile breakpoint. The majority of annual geometric excess returns of factor portfolios and composite portfolios are significantly higher than the excess return for reference market portfolio-XUTUM_CFNNTLTL and the excess return for BIST-100 index in the analysis

period June 1993-June 2019 as well as in the two-sub-periods. As depicted earlier, the sub-period of June 1993-June 2002 was characterized by negative excess returns due to the adverse macroeconomic conditions of this period. The annual geometric excess returns on the entire analysis period of June 1993-June 2019 also suffer from the spillover effect from the earlier sub-period of June 1993-June 2002. In contrast, the sub-period of June 2003-June 2019 proved to be the most robust annual geometric excess return performance relative to other analysis periods. During this sub-period, annual geometric portfolio excess returns are considerably above the excess return for reference market portfolio-XUTUM_CFNNTLTL and the excess return for BIST-100. Best excess return performers in this sub-period were "Gross Dividend Yield," "Return on Equity-ROE," "Standard Deviation," "Net Earnings to Price," and "Book to Price." Even though the 30th percentile breakpoint long-only factor investing portfolios have registered a much higher geometric return than their fundamental indexation risk factor counterparts, they seem to register a comparatively modest performance than their median breakpoint counterparts.

The annualized Sharpe ratios of the best performing 30th percentile breakpoint factor investing portfolios are also considerably higher than the Sharpe ratios of the reference market portfolio-XUTUM_CFNNTLTL, BIST-100, and their fundamental indexation risk factor counterparts.

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Book to Price-Value			
Avg. Annual Arithmetic Excess Return	20.36%	9.45%	13.49%
Standard Deviation	91.56%	23.73%	57.25%
Annual Geometric Excess Return	-11.89%	7.04%	-0.40%
Annualized Sharpe Ratio*	22.65%	39.46%	25.63%

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	28.20	317.75	89.62
Net Earnings to Price-Value			
Avg. Annual Arithmetic Excess Return	8.62%	10.34%	9.71%
Standard Deviation	75.83%	26.16%	49.11%
Annual Geometric Excess Return	-17.49%	7.39%	-2.59%
Annualized Sharpe Ratio*	12.30%	37.94%	21.47%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	14.63	336.21	49.19
EBIT-DA-Value			
Avg. Annual Arithmetic Excess Return	-7.62%	5.71%	0.78%
Standard Deviation	53.78%	20.39%	36.06%
Annual Geometric Excess Return	-23.05%	3.81%	-7.08%
Annualized Sharpe Ratio*	-6.71%	27.33%	7.14%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	7.28	188.95	13.76
Total MCAP-Small Size			
Avg. Annual Arithmetic Excess Return	20.57%	5.57%	11.12%
Standard Deviation	95.18%	22.76%	59.24%
Annual Geometric Excess Return	-13.69%	3.33%	-3.33%
Annualized Sharpe Ratio*	17.57%	25.85%	18.81%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	22.95	174.60	40.07
Free Float MCAP-Small Size			
Avg. Annual Arithmetic Excess Return	19.03%	7.66%	11.87%
Standard Deviation	91.54%	27.04%	58.15%
Annual Geometric Excess Return	-13.27%	4.68%	-2.36%
Annualized Sharpe Ratio*	19.04%	30.62%	21.27%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	24.07	217.75	52.41
Standard Deviation-Low Volatility			
Avg. Annual Arithmetic Excess Return	-5.28%	10.11%	4.41%
Standard Deviation	62.33%	23.55%	41.76%
Annual Geometric Excess Return	-23.39%	7.73%	-5.05%
Annualized Sharpe Ratio*	-4.29%	41.81%	12.72%

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	6.96	354.52	24.67
Beta-Low Volatility			
Avg. Annual Arithmetic Excess Return	1.40%	5.95%	4.26%
Standard Deviation	57.84%	20.35%	37.65%
Annual Geometric Excess Return	-15.04%	4.09%	-3.45%
Annualized Sharpe Ratio*	8.68%	29.08%	14.67%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	19.59	197.68	38.72
Gross Dividend Yield-High Yield			
Avg. Annual Arithmetic Excess Return	14.19%	15.56%	15.06%
Standard Deviation	76.95%	28.84%	50.62%
Annual Geometric Excess Return	-11.93%	12.61%	2.81%
Annualized Sharpe Ratio*	21.89%	50.28%	31.59%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	28.07	752.51	211.26
ROE-Quality			
Avg. Annual Arithmetic Excess Return	-2.09%	14.69%	8.48%
Standard Deviation	60.95%	45.70%	51.38%
Annual Geometric Excess Return	-20.51%	8.89%	-3.09%
Annualized Sharpe Ratio*	-0.96%	38.37%	18.51%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	10.08	425.36	42.86
Trailing Five-year Average Earnings Growth-Quality			
Avg. Annual Arithmetic Excess Return	-19.97%	-1.66%	-8.44%
Standard Deviation	54.98%	21.65%	37.63%
Annual Geometric Excess Return	-38.37%	-4.05%	-18.56%
Annualized Sharpe Ratio*	-25.01%	2.89%	-12.23%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	0.79	49.53	0.39
Financial Leverage-Quality			
Avg. Annual Arithmetic Excess Return	-1.84%	4.04%	1.86%
Standard Deviation	50.41%	19.68%	33.56%
Annual Geometric Excess Return	-15.27%	2.14%	-4.69%

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Annualized Sharpe Ratio*	17.34%	22.41%	17.31%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	19.06	143.43	27.34
Momentum-Momentum			
Avg. Annual Arithmetic Excess Return	-4.90%	1.41%	-0.92%
Standard Deviation	55.73%	16.91%	35.51%
Annual Geometric Excess Return	-21.74%	0.01%	-8.68%
Annualized Sharpe Ratio*	-2.43%	12.77%	3.12%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	8.61	100.09	8.62
Composite-Value			
Avg. Annual Arithmetic Excess Return	7.70%	8.69%	8.33%
Standard Deviation	72.08%	21.33%	45.59%
Annual Geometric Excess Return	-15.97%	6.64%	-2.37%
Annualized Sharpe Ratio*	10.39%	37.49%	19.21%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	17.56	298.08	52.35
Composite-Small Size			
Avg. Annual Arithmetic Excess Return	20.05%	6.61%	11.59%
Standard Deviation	93.34%	24.52%	58.56%
Annual Geometric Excess Return	-13.17%	4.09%	-2.67%
Annualized Sharpe Ratio*	18.43%	28.58%	20.20%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	24.36	197.81	48.18
Composite-Low Volatility			
Avg. Annual Arithmetic Excess Return	0.02%	7.99%	5.04%
Standard Deviation	60.32%	20.48%	39.15%
Annual Geometric Excess Return	-17.73%	6.14%	-3.42%
Annualized Sharpe Ratio*	2.20%	37.30%	14.38%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	14.20	275.54	39.13
Composite-High Yield			
Avg. Annual Arithmetic Excess Return	14.19%	15.56%	15.06%
Standard Deviation	76.95%	28.84%	50.62%
Annual Geometric Excess Return	-11.93%	12.61%	2.81%

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Annualized Sharpe Ratio*	21.89%	50.28%	31.59%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	28.07	752.51	211.26
Composite-Quality			
Avg. Annual Arithmetic Excess Return	-5.87%	5.08%	1.03%
Standard Deviation	54.94%	18.98%	36.00%
Annual Geometric Excess Return	-22.14%	3.42%	-6.90%
Annualized Sharpe Ratio*	-2.62%	26.02%	8.94%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	8.19	177.15	14.51
Composite-Momentum			
Avg. Annual Arithmetic Excess Return	-4.90%	1.41%	-0.92%
Standard Deviation	55.73%	16.91%	35.51%
Annual Geometric Excess Return	-21.74%	0.01%	-8.68%
Annualized Sharpe Ratio*	-2.43%	12.77%	3.12%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	8.61	100.09	8.62
Composite-All Factors			
Avg. Annual Arithmetic Excess Return	5.91%	7.53%	6.93%
Standard Deviation	67.23%	18.76%	42.21%
Annual Geometric Excess Return	-15.47%	5.96%	-2.55%
Annualized Sharpe Ratio*	8.78%	35.67%	17.60%
Excess Return Index Value-Start	100.00	100.00	100.00
Excess Return Index Value-End	18.61	267.37	49.77
Total Return Index - (XUTUM_CFNNTLTL)			
Avg. Annual Arithmetic Excess Return	-7.87%	3.80%	-0.52%
Standard Deviation	51.04%	20.42%	34.52%
Annual Geometric Excess Return	-23.36%	1.84%	-8.34%
Annualized Sharpe Ratio*	-5.24%	20.63%	5.16%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	32,257.63	1,603.20	517,155.51
Excess Return Index Value-End	6.99	136.35	9.53
BIST-100			
Avg. Annual Arithmetic Excess Return	-11.45%	1.21%	-3.47%

Table 9. Annual Excess Returns-(Portfolio Return - R_f) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint

	June 1993-June 2002	June 2003-June 2019	June 1993-June 2019
Standard Deviation	50.22%	20.51%	34.21%
Annual Geometric Excess Return	-26.22%	-0.81%	-11.11%
Annualized Sharpe Ratio*	-11.48%	11.81%	-1.42%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	21,284.14	1,028.64	218,936.51
Excess Return Index Value-End	4.78	87.02	4.16
R_f - Risk Free Rate			
Avg. Annual Arithmetic Return	117.75%	16.07%	53.73%
Standard Deviation	46.18%	12.17%	57.73%
Annual Geometric Return	113.89%	15.54%	45.14%
Return Index Value-Start	100.00	100.00	100.00
Return Index Value-End	200,419.19	1,164.50	2,333,874.41

Note: * Ex-post Sharpe Ratio (revised version) William F. Sharpe (1994).

5.5 Fundamental indexation portfolios' excess returns over market proxy

Table 10, Table 11 and Table 12 show the annualized arithmetic and geometric excess returns of fundamental indexation portfolios over the reference market portfolio XUTUM_ CFNNTLTL and BIST-100 index. The annualized geometric excess returns of factor portfolios and the composite portfolio are all positive in the analysis period of June 1993-June 2019 and the two-sub-periods. The majority of the information ratios of factor portfolios show that fundamental indexation risk factor portfolios carry a sizeable potential to deliver hefty risk-adjusted active returns even in bleak macroeconomic environments like the sub-period of June 1993-June 2002. Other than the sub-period of June 1993-June 2002, Table 11 and Table 12 indicate that most risk-adjusted active returns for fundamental index risk factor portfolios are also reliably superior to a risk-equivalent reference market portfolio; in our case, the

total return index of XUTUM_CFNNTLTL. Hence, they are statistically significant within the 95% confidence interval and above.

Although many information ratios are at an acceptable range, most of the t-scores for the sub-period of June 1993-June 2002 were far from statistically significant, staying out of the 95% confidence level. Substituting our reference market portfolio XUTUM_CFNNTLTL with BIST-100 changes this bleak picture dramatically. In this case, there remains only one risk factor portfolio, "Trailing Five-year Average Cash Flow," that is not statistically significant, registering a t-test score of 1.888, far below the 95% confidence level threshold of 2.262. Even this tiny example clearly shows that an improper selection of a reference market portfolio has the potential to distort the empirical findings and jeopardize the credentials of an academic study. The t-scores in the entire analysis period of June 1993-June 2019 show that apart from the "Trailing Five-year Average Cash Flow" risk factor portfolio's t-score, all other t-scores stayed in the 95% confidence level and above. As expected, the sub-period of June 2003-June 2019 provided the most robust results in terms of statistical significance. However, the information ratios show a relatively subdued performance compared to other periods.

Table 10. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Book Value		
Annualized Arithmetic Mean Excess Return	20.89%	15.38%
Standard Error of Excess Return	41.40%	39.68%
Annualized Geometric Mean Excess Return	13.36%	9.50%
Information Ratio	96.00%	80.39%
Tracking Error	5.61%	5.21%

Table 10. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
T-Score	2.735	**	2.229	*
Trailing Five-year Average Net Sales				
Annualized Arithmetic Mean Excess Return	22.08%		16.57%	
Standard Error of Excess Return	29.10%		31.84%	
Annualized Geometric Mean Excess Return	14.13%		10.24%	
Information Ratio	82.94%		69.40%	
Tracking Error	6.53%		6.08%	
T-Score	3.931	***	2.815	**
Trailing Five-year Average Gross Dividends				
Annualized Arithmetic Mean Excess Return	17.39%		11.87%	
Standard Error of Excess Return	35.22%		27.13%	
Annualized Geometric Mean Excess Return	11.12%		7.34%	
Information Ratio	77.57%		65.92%	
Tracking Error	5.05%		4.13%	
T-Score	2.401	**	2.204	*
Trailing Five-year Average Cash Flow				
Annualized Arithmetic Mean Excess Return	10.67%		5.16%	
Standard Error of Excess Return	31.66%		38.71%	
Annualized Geometric Mean Excess Return	6.82%		3.19%	
Information Ratio	41.03%		24.11%	
Tracking Error	41.03%		6.10%	
T-Score	1.888	*	0.905	
Composite-AHM				
Annualized Arithmetic Mean Excess Return	18.33%		12.82%	
Standard Error of Excess Return	26.08%		26.34%	
Annualized Geometric Mean Excess Return	11.73%		7.92%	
Information Ratio	83.47%		68.34%	
Tracking Error	5.21%		4.61%	
T-Score	3.582	***	2.606	**

Note: *** p<0.01, ** Sp<0.05, * p<0.10.

Table 11. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Book Value				
Annualized Arithmetic Mean Excess Return	5.46%		2.42%	
Standard Error of Excess Return	3.48%		3.92%	
Annualized Geometric Mean Excess Return	4.76%		2.06%	
Information Ratio	98.27%		54.27%	
Tracking Error	1.41%		1.29%	
T-Score	6.692	***	2.861	**
Trailing Five-year Average Net Sales				
Annualized Arithmetic Mean Excess Return	7.20%		4.17%	
Standard Error of Excess Return	7.25%		7.24%	
Annualized Geometric Mean Excess Return	6.28%		3.54%	
Information Ratio	87.68%		59.18%	
Tracking Error	1.98%		1.77%	
T-Score	4.015	***	2.358	**
Trailing Five-year Average Gross Dividends				
Annualized Arithmetic Mean Excess Return	8.85%		5.82%	
Standard Error of Excess Return	11.13%		11.66%	
Annualized Geometric Mean Excess Return	7.72%		4.94%	
Information Ratio	53.45%		38.32%	
Tracking Error	4.33%		4.25%	
T-Score	3.723	***	2.520	**
Trailing Five-year Average Cash Flow				
Annualized Arithmetic Mean Excess Return	7.06%		4.02%	
Standard Error of Excess Return	7.98%		7.92%	
Annualized Geometric Mean Excess Return	6.15%		3.42%	
Information Ratio	67.46%		42.66%	
Tracking Error	2.35%		2.10%	
T-Score	3.564	***	2.068	*
Composite-AHM				
Annualized Arithmetic Mean Excess Return	7.34%		4.31%	
Standard Error of Excess Return	3.93%		4.44%	
Annualized Geometric Mean Excess Return	6.40%		3.66%	
Information Ratio	90.69%		61.56%	
Tracking Error	1.94%		1.73%	

Table 11. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
T-Score	7.875	***	4.261	***

Note: *** p<0.01, ** Sp<0.05, * p<0.10.

Table 12. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book Value				
Annualized Arithmetic Mean Excess Return	11.80%		7.50%	
Standard Error of Excess Return	28.65%		26.62%	
Annualized Geometric Mean Excess Return	8.87%		5.46%	
Information Ratio	79.11%		59.32%	
Tracking Error	3.63%		3.36%	
T-Score	3.049	***	2.356	**
Trailing Five-year Average Net Sales				
Annualized Arithmetic Mean Excess Return	13.55%		9.25%	
Standard Error of Excess Return	23.04%		22.91%	
Annualized Geometric Mean Excess Return	10.19%		6.74%	
Information Ratio	72.16%		55.92%	
Tracking Error	4.29%		3.97%	
T-Score	4.025	***	2.972	***
Trailing Five-year Average Gross Dividends				
Annualized Arithmetic Mean Excess Return	13.06%		8.76%	
Standard Error of Excess Return	23.94%		19.29%	
Annualized Geometric Mean Excess Return	9.82%		6.38%	
Information Ratio	63.11%		48.41%	
Tracking Error	4.61%		4.20%	
T-Score	3.523	***	3.095	***
Trailing Five-year Average Cash Flow				
Annualized Arithmetic Mean Excess Return	9.20%		4.90%	

Table 12. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Standard Error of Excess Return	20.52%		23.87%	
Annualized Geometric Mean Excess Return	6.92%		3.57%	
Information Ratio	45.48%		27.30%	
Tracking Error	4.36%		4.06%	
T-Score	2.873	***	1.438	
Composite-AHM				
Annualized Arithmetic Mean Excess Return	12.28%		7.98%	
Standard Error of Excess Return	19.04%		17.98%	
Annualized Geometric Mean Excess Return	9.24%		5.81%	
Information Ratio	76.88%		58.73%	
Tracking Error	3.53%		3.13%	
T-Score	4.276	***	3.157	***

Note: *** p<0.01, ** Sp<0.05, * p<0.10.

5.6 Factor investing portfolios' excess returns over market proxy

5.6.1 Excess return of factor investing portfolios over market proxy constructed according to the median breakpoint

Table 13, Table 14 and Table 15 show factor investing portfolios' annualized arithmetic and geometric excess returns over the reference market portfolio XUTUM_ CFNNTLTL and BIST-100 index. Apart from "EBIT-DA," "Trailing Five-year Average Earnings Growth," and "Financial Leverage," the annualized geometric excess returns of factor investing portfolios and the composite portfolios are all positive in the analysis period of June 1993-June 2019 as well as in the two-sub-periods. Like fundamental indexation risk factor portfolios, most information ratios show that factor investing risk factor portfolios carry a sizeable potential to

deliver hefty risk-adjusted active returns even in bleak macroeconomic environments like the sub-period of June 1993-June 2002. However, in the case of t-test scores and statistical significance, similarities with fundamental indexation risk factor portfolios fade, especially in the sub-period of June 1993-June 2002. Although not catastrophic, the t-scores in the entire analysis period of June 1993-June 2019 are also far from a rosier picture. Only three risk factor portfolios have t-scores at 95% confidence level and above. However, suppose we substitute our reference market portfolio XUTUM_CFNNTLTL with BIST-100. In that case, five different risk factor portfolios become statistically significant within the 95% confidence interval in addition to the existing three. Substituting BIST-100 as the reference market portfolio seems to create a falsehood of statistical significance even though, in reality, there is none.

Contrary to our expectations, the sub-period of June 2003-June 2019 provided a dismal result in terms of statistical significance. There are only three risk factor portfolios that are statistically significant at a 95% confidence level, namely, "Book to Price," "Standard Deviation," and "Gross Dividend Yield ." Even the substitution of the BIST-100 index as a reference market portfolio can not improve the general picture. Only two more factors become statistically significant within the 95% confidence level and above, namely, "Net Earnings to Price" and "EBITDA ." Similar to the case in fundamental indexation, the information ratios also seem to show a relatively subdued performance compared to other periods.

Table 13. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Book to Price-Value				
Annualized Arithmetic Mean Excess Return	30.15%		24.64%	
Standard Error of Excess Return	97.48%		96.60%	
Annualized Geometric Mean Excess Return	19.29%		15.22%	
Information Ratio	71.10%		59.48%	
Tracking Error	10.37%		10.39%	
T-Score	2.172	*	1.936	*
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	17.63%		12.11%	
Standard Error of Excess Return	57.97%		57.06%	
Annualized Geometric Mean Excess Return	11.28%		7.49%	
Information Ratio	47.18%		35.09%	
Tracking Error	8.87%		8.53%	
T-Score	1.971	*	1.569	
EBIT-DA-Value				
Annualized Arithmetic Mean Excess Return	5.28%		-0.23%	
Standard Error of Excess Return	26.86%		36.07%	
Annualized Geometric Mean Excess Return	3.38%		-0.14%	
Information Ratio	17.87%		-6.63%	
Tracking Error	4.99%		4.57%	
T-Score	1.090		0.125	
Total MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	16.90%		11.39%	
Standard Error of Excess Return	69.78%		70.90%	
Annualized Geometric Mean Excess Return	10.81%		7.04%	
Information Ratio	36.46%		27.61%	
Tracking Error	11.98%		11.50%	
T-Score	1.751		1.374	
Free Float MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	16.35%		10.84%	
Standard Error of Excess Return	72.21%		74.23%	
Annualized Geometric Mean Excess Return	10.46%		6.70%	
Information Ratio	39.02%		26.37%	
Tracking Error	9.62%		9.71%	

Table 13. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
T-Score	1.596		1.219	
Standard Deviation-Low Volatility				
Annualized Arithmetic Mean Excess Return	9.98%		4.47%	
Standard Error of Excess Return	43.60%		48.14%	
Annualized Geometric Mean Excess Return	6.38%		2.76%	
Information Ratio	22.28%		7.91%	
Tracking Error	8.10%		7.71%	
T-Score	1.446		0.795	
Beta-Low Volatility				
Annualized Arithmetic Mean Excess Return	17.23%		11.71%	
Standard Error of Excess Return	42.69%		42.51%	
Annualized Geometric Mean Excess Return	11.02%		7.24%	
Information Ratio	43.20%		29.88%	
Tracking Error	7.30%		6.55%	
T-Score	1.922	*	1.348	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	26.51%		21.00%	
Standard Error of Excess Return	63.69%		64.18%	
Annualized Geometric Mean Excess Return	16.96%		12.98%	
Information Ratio	58.84%		49.54%	
Tracking Error	10.72%		10.32%	
T-Score	2.438	**	2.033	*
ROE-Quality				
Annualized Arithmetic Mean Excess Return	11.43%		5.91%	
Standard Error of Excess Return	34.73%		36.40%	
Annualized Geometric Mean Excess Return	7.31%		3.65%	
Information Ratio	24.92%		11.37%	
Tracking Error	8.32%		7.72%	
T-Score	1.833		1.068	
Trailing Five-year Average Earnings Growth-Quality				
Annualized Arithmetic Mean Excess Return	-16.94%		-22.45%	
Standard Error of Excess Return	75.13%		82.70%	

Table 13. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Annualized Geometric Mean Excess Return	-10.83%		-13.87%
Information Ratio	-22.04%		-29.54%
Tracking Error	14.82%		15.10%
T-Score	-0.404		-0.667
Financial Leverage-Quality			
Annualized Arithmetic Mean Excess Return	18.08%		12.57%
Standard Error of Excess Return	35.89%		40.29%
Annualized Geometric Mean Excess Return	11.57%		7.77%
Information Ratio	53.46%		46.11%
Tracking Error	11.68%		10.95%
T-Score	2.306	**	1.439
Momentum-Momentum			
Annualized Arithmetic Mean Excess Return	9.84%		4.33%
Standard Error of Excess Return	32.63%		27.89%
Annualized Geometric Mean Excess Return	6.29%		2.67%
Information Ratio	53.42%		29.08%
Tracking Error	4.20%		3.61%
T-Score	1.520		0.890
Composite-Value			
Annualized Arithmetic Mean Excess Return	18.90%		13.39%
Standard Error of Excess Return	55.28%		56.59%
Annualized Geometric Mean Excess Return	12.09%		8.27%
Information Ratio	57.82%		42.54%
Tracking Error	7.18%		6.95%
T-Score	2.141	*	1.654
Composite-Small Size			
Annualized Arithmetic Mean Excess Return	17.86%		12.35%
Standard Error of Excess Return	78.32%		79.56%
Annualized Geometric Mean Excess Return	11.43%		7.63%
Information Ratio	40.32%		29.16%
Tracking Error	10.07%		9.83%
T-Score	1.645		1.308
Composite-Low Volatility			

Table 13. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Annualized Arithmetic Mean Excess Return	14.20%		8.69%	
Standard Error of Excess Return	40.61%		43.00%	
Annualized Geometric Mean Excess Return	9.08%		5.37%	
Information Ratio	34.80%		19.69%	
Tracking Error	7.12%		6.52%	
T-Score	1.828		1.151	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	26.51%		21.00%	
Standard Error of Excess Return	63.69%		64.18%	
Annualized Geometric Mean Excess Return	16.96%		12.98%	
Information Ratio	58.84%		49.54%	
Tracking Error	10.72%		10.32%	
T-Score	2.438	**	2.033	*
Composite-Quality				
Annualized Arithmetic Mean Excess Return	7.73%		2.22%	
Standard Error of Excess Return	44.61%		51.70%	
Annualized Geometric Mean Excess Return	4.95%		1.37%	
Information Ratio	20.93%		6.37%	
Tracking Error	8.04%		7.66%	
T-Score	1.103		0.473	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	9.84%		4.33%	
Standard Error of Excess Return	32.63%		27.89%	
Annualized Geometric Mean Excess Return	6.29%		2.67%	
Information Ratio	53.42%		29.08%	
Tracking Error	4.20%		3.61%	
T-Score	1.520		0.890	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	17.35%		11.83%	
Standard Error of Excess Return	44.42%		46.40%	
Annualized Geometric Mean Excess Return	11.10%		7.31%	
Information Ratio	52.52%		37.08%	
Tracking Error	6.64%		6.18%	
T-Score	2.208	*	1.580	

Table 13. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002

Note: * p<0.90, ** p<0.95, *** p<0.99.

Table 14. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Book to Price-Value				
Annualized Arithmetic Mean Excess Return	9.94%		6.91%	
Standard Error of Excess Return	12.49%		11.76%	
Annualized Geometric Mean Excess Return	8.67%		5.87%	
Information Ratio	46.04%		33.35%	
Tracking Error	4.67%		4.39%	
T-Score	3.268	***	2.446	**
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	10.71%		7.68%	
Standard Error of Excess Return	18.12%		17.95%	
Annualized Geometric Mean Excess Return	9.34%		6.52%	
Information Ratio	48.14%		36.81%	
Tracking Error	5.36%		5.13%	
T-Score	2.474	**	1.826	*
EBIT-DA-Value				
Annualized Arithmetic Mean Excess Return	5.99%		2.96%	
Standard Error of Excess Return	7.39%		7.46%	
Annualized Geometric Mean Excess Return	5.23%		2.51%	
Information Ratio	60.85%		33.63%	
Tracking Error	2.26%		2.04%	
T-Score	3.176	***	1.528	
Total MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	3.30%		0.27%	
Standard Error of Excess Return	13.04%		12.43%	

Table 14. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Annualized Geometric Mean Excess Return	2.88%		0.23%	
Information Ratio	12.06%		-1.90%	
Tracking Error	4.98%		4.60%	
T-Score	0.952		0.029	
Free Float MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	5.73%		2.70%	
Standard Error of Excess Return	14.59%		14.01%	
Annualized Geometric Mean Excess Return	5.00%		2.29%	
Information Ratio	23.31%		10.73%	
Tracking Error	5.17%		4.81%	
T-Score	1.472		0.673	
Standard Deviation-Low Volatility				
Annualized Arithmetic Mean Excess Return	9.48%		6.45%	
Standard Error of Excess Return	8.94%		8.49%	
Annualized Geometric Mean Excess Return	8.27%		5.48%	
Information Ratio	53.48%		39.70%	
Tracking Error	3.94%		3.58%	
T-Score	4.501	***	3.324	***
Beta-Low Volatility				
Annualized Arithmetic Mean Excess Return	4.35%		1.32%	
Standard Error of Excess Return	14.99%		14.18%	
Annualized Geometric Mean Excess Return	3.79%		1.12%	
Information Ratio	13.71%		-1.41%	
Tracking Error	4.58%		4.25%	
T-Score	0.987		0.194	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	15.46%		12.42%	
Standard Error of Excess Return	16.29%		16.99%	
Annualized Geometric Mean Excess Return	13.48%		10.55%	
Information Ratio	61.99%		52.22%	
Tracking Error	5.96%		5.76%	
T-Score	4.235	***	3.351	***
ROE-Quality				

Table 14. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019	Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019
Annualized Arithmetic Mean Excess Return	11.67%	8.64%
Standard Error of Excess Return	44.26%	44.69%
Annualized Geometric Mean Excess Return	10.18%	7.34%
Information Ratio	39.98%	32.21%
Tracking Error	8.37%	8.26%
T-Score	1.347	1.064
Trailing Five-year Average Earnings Growth-Quality		
Annualized Arithmetic Mean Excess Return	-2.93%	-5.97%
Standard Error of Excess Return	20.79%	20.58%
Annualized Geometric Mean Excess Return	-2.56%	-5.07%
Information Ratio	-8.63%	-19.69%
Tracking Error	6.57%	6.38%
T-Score	-0.552	-1.143
Financial Leverage-Quality		
Annualized Arithmetic Mean Excess Return	2.90%	-0.13%
Standard Error of Excess Return	11.42%	11.07%
Annualized Geometric Mean Excess Return	2.53%	-0.11%
Information Ratio	19.81%	3.87%
Tracking Error	4.27%	4.08%
T-Score	1.043	-0.013
Momentum-Momentum		
Annualized Arithmetic Mean Excess Return	3.51%	0.48%
Standard Error of Excess Return	6.48%	5.90%
Annualized Geometric Mean Excess Return	3.06%	0.41%
Information Ratio	37.03%	0.41%
Tracking Error	1.88%	1.71%
T-Score	1.813 *	-0.053
Composite-Value		
Annualized Arithmetic Mean Excess Return	9.31%	6.28%
Standard Error of Excess Return	9.70%	9.32%
Annualized Geometric Mean Excess Return	8.12%	5.34%
Information Ratio	59.10%	42.78%
Tracking Error	3.44%	3.15%

Table 14. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
T-Score	3.807	***	2.671	**
Composite-Small Size				
Annualized Arithmetic Mean Excess Return	4.55%		1.52%	
Standard Error of Excess Return	13.61%		13.01%	
Annualized Geometric Mean Excess Return	3.97%		1.29%	
Information Ratio	18.01%		4.62%	
Tracking Error	5.01%		4.64%	
T-Score	1.249		0.381	
Composite-Low Volatility				
Annualized Arithmetic Mean Excess Return	7.07%		4.04%	
Standard Error of Excess Return	9.89%		9.02%	
Annualized Geometric Mean Excess Return	6.17%		3.43%	
Information Ratio	34.70%		19.08%	
Tracking Error	3.95%		3.57%	
T-Score	2.766	**	1.697	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	15.46%		12.42%	
Standard Error of Excess Return	16.29%		16.99%	
Annualized Geometric Mean Excess Return	13.48%		10.55%	
Information Ratio	61.99%		52.22%	
Tracking Error	5.96%		5.76%	
T-Score	4.235	***	3.351	
Composite-Quality				
Annualized Arithmetic Mean Excess Return	4.97%		1.94%	
Standard Error of Excess Return	14.49%		14.68%	
Annualized Geometric Mean Excess Return	4.34%		1.65%	
Information Ratio	25.82%		11.67%	
Tracking Error	4.68%		4.46%	
T-Score	1.222		0.385	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	3.51%		0.48%	
Standard Error of Excess Return	6.48%		5.90%	
Annualized Geometric Mean Excess Return	3.06%		0.41%	

Table 14. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Information Ratio	37.03%		0.41%	
Tracking Error	1.88%		1.71%	
T-Score	1.813	*	-0.053	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	7.87%		4.83%	
Standard Error of Excess Return	5.08%		4.73%	
Annualized Geometric Mean Excess Return	6.86%		4.11%	
Information Ratio	49.25%		32.09%	
Tracking Error	3.35%		3.00%	
T-Score	5.922	***	3.807	***

Note: * p<0.90, ** p<0.95, *** p<0.99.

Table 15. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book to Price-Value				
Annualized Arithmetic Mean Excess Return	18.57%		14.27%	
Standard Error of Excess Return	64.61%		63.04%	
Annualized Geometric Mean Excess Return	13.97%		10.39%	
Information Ratio	55.66%		44.39%	
Tracking Error	7.34%		7.23%	
T-Score	2.496	**	2.167	**
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	14.53%		10.23%	
Standard Error of Excess Return	38.98%		37.76%	
Annualized Geometric Mean Excess Return	10.93%		7.45%	
Information Ratio	46.25%		34.90%	
Tracking Error	6.86%		6.59%	
T-Score	2.696	**	2.131	**

Table 15. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019
EBIT-DA-Value			
Annualized Arithmetic Mean Excess Return	6.38%		2.08%
Standard Error of Excess Return	16.92%		22.03%
Annualized Geometric Mean Excess Return	4.80%		1.51%
Information Ratio	33.97%		9.96%
Tracking Error	3.52%		3.21%
T-Score	2.152	**	0.535
Total MCAP-Small Size			
Annualized Arithmetic Mean Excess Return	8.71%		4.41%
Standard Error of Excess Return	45.80%		45.43%
Annualized Geometric Mean Excess Return	6.55%		3.21%
Information Ratio	24.07%		14.20%
Tracking Error	8.29%		7.89%
T-Score	1.839	*	1.311
Free Float MCAP-Small Size			
Annualized Arithmetic Mean Excess Return	10.35%		6.05%
Standard Error of Excess Return	46.60%		46.86%
Annualized Geometric Mean Excess Return	7.78%		4.40%
Information Ratio	30.09%		18.12%
Tracking Error	7.14%		7.02%
T-Score	1.870	*	1.334
Standard Deviation-Low Volatility			
Annualized Arithmetic Mean Excess Return	10.72%		6.42%
Standard Error of Excess Return	27.06%		29.21%
Annualized Geometric Mean Excess Return	8.06%		4.67%
Information Ratio	34.27%		20.47%
Tracking Error	5.83%		5.48%
T-Score	2.598	**	1.564
Beta-Low Volatility			
Annualized Arithmetic Mean Excess Return	9.63%		5.33%
Standard Error of Excess Return	29.84%		28.69%
Annualized Geometric Mean Excess Return	7.24%		3.88%
Information Ratio	27.24%		13.17%

Table 15. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Tracking Error	5.74%		5.22%	
T-Score	2.067	**	1.291	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	21.40%		17.10%	
Standard Error of Excess Return	42.68%		42.26%	
Annualized Geometric Mean Excess Return	16.09%		12.46%	
Information Ratio	57.93%		48.82%	
Tracking Error	8.05%		7.76%	
T-Score	3.497	***	2.948	***
ROE-Quality				
Annualized Arithmetic Mean Excess Return	12.87%		8.57%	
Standard Error of Excess Return	40.38%		41.08%	
Annualized Geometric Mean Excess Return	9.68%		6.24%	
Information Ratio	34.47%		24.82%	
Tracking Error	8.34%		8.05%	
T-Score	2.130	**	1.494	
Trailing Five-year Average Earnings Growth-Quality				
Annualized Arithmetic Mean Excess Return	-8.65%		-12.95%	
Standard Error of Excess Return	47.24%		51.59%	
Annualized Geometric Mean Excess Return	-6.51%		-9.44%	
Information Ratio	-15.06%		-23.32%	
Tracking Error	10.41%		10.48%	
T-Score	-0.584		-1.012	
Financial Leverage-Quality				
Annualized Arithmetic Mean Excess Return	8.84%		4.54%	
Standard Error of Excess Return	25.64%		26.81%	
Annualized Geometric Mean Excess Return	6.65%		3.31%	
Information Ratio	36.05%		26.53%	
Tracking Error	7.89%		7.42%	
T-Score	2.333	**	1.312	
Momentum-Momentum				
Annualized Arithmetic Mean Excess Return	6.27%		1.97%	

Table 15. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Standard Error of Excess Return	20.84%		17.49%	
Annualized Geometric Mean Excess Return	4.72%		1.44%	
Information Ratio	42.87%		15.25%	
Tracking Error	2.96%		2.58%	
T-Score	1.896	*	0.850	
Composite-Value				
Annualized Arithmetic Mean Excess Return	13.97%		9.67%	
Standard Error of Excess Return	36.22%		36.01%	
Annualized Geometric Mean Excess Return	10.51%		7.04%	
Information Ratio	54.72%		39.60%	
Tracking Error	5.15%		4.91%	
T-Score	2.798	***	2.131	**
Composite-Small Size				
Annualized Arithmetic Mean Excess Return	10.01%		5.71%	
Standard Error of Excess Return	50.62%		50.39%	
Annualized Geometric Mean Excess Return	7.53%		4.16%	
Information Ratio	28.37%		17.05%	
Tracking Error	7.31%		7.02%	
T-Score	1.816	*	1.335	
Composite-Low Volatility				
Annualized Arithmetic Mean Excess Return	10.55%		6.24%	
Standard Error of Excess Return	26.45%		26.92%	
Annualized Geometric Mean Excess Return	7.93%		4.55%	
Information Ratio	33.34%		18.58%	
Tracking Error	5.34%		4.87%	
T-Score	2.529	**	1.570	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	21.40%		17.10%	
Standard Error of Excess Return	42.68%		42.26%	
Annualized Geometric Mean Excess Return	16.09%		12.46%	
Information Ratio	57.93%		48.82%	
Tracking Error	8.05%		7.76%	
T-Score	3.497	***	2.948	***

Table 15. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Composite-Quality				
Annualized Arithmetic Mean Excess Return	6.56%		2.26%	
Standard Error of Excess Return	29.13%		32.67%	
Annualized Geometric Mean Excess Return	4.94%		1.65%	
Information Ratio	22.58%		8.70%	
Tracking Error	6.13%		5.84%	
T-Score	1.510		0.592	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	6.27%		1.97%	
Standard Error of Excess Return	20.84%		17.49%	
Annualized Geometric Mean Excess Return	4.72%		1.44%	
Information Ratio	42.87%		15.25%	
Tracking Error	2.96%		2.58%	
T-Score	1.896	*	0.850	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	12.31%		8.01%	
Standard Error of Excess Return	28.90%		29.06%	
Annualized Geometric Mean Excess Return	9.26%		5.83%	
Information Ratio	48.22%		32.73%	
Tracking Error	4.83%		4.45%	
T-Score	2.891	***	2.027	*

Note: * p<0.90, ** p<0.95, *** p<0.99.

5.6.2 Excess return of factor investing portfolios over market proxy constructed according to the 30th percentile breakpoint

Table 16, Table 17 and Table 18 show factor investing portfolios' annualized arithmetic and geometric excess returns over the reference market portfolio XUTUM_ CFNNTLTL and BIST-100 index. Apart from "EBIT-DA," "Trailing Five-year Average Earnings Growth," and "Momentum," the annualized geometric excess returns of factor investing portfolios and the composite portfolios are all

positive in the analysis period of June 1993-June 2019 as well as in the two-sub-periods. As compared to the median breakpoint, size factor portfolios seem to perform better in the 30th percentile breakpoint. However, a more general assessment reveals some cavities in its relative performance, especially in terms of statistical significance. There is not much difference in statistical significance between the two breakpoints in the sub-period of June 1993-June 2002, i.e., there is no risk factor that is statistically significant within a 95% confidence interval. The t-scores for 30th percentile portfolios in the entire period of June 1993-June 2019 are comparatively low. Only two risk factor portfolios have t-scores staying in the 95% confidence level and above, instead of three as in the case of the median breakpoint.

The sub-period of June 2003-June 2019 provided a relatively negative result in terms of statistical significance. There are only two (three in the case of median breakpoint) risk factor portfolios that are statistically significant at a 95% confidence level, namely, "Standard Deviation" and "Gross Dividend Yield ."Even the substitution of the BIST-100 index as a reference market portfolio can not improve the general picture. Only two more factors become statistically significant within the 95% confidence interval and above, namely, "Book to Price" and "EBITDA ."Similar to the case in fundamental indexation, the information ratios also seem to show a relatively subdued performance compared to other periods.

Table 16. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Book to Price-Value		
Annualized Arithmetic Mean Excess Return	28.05%	22.54%

Table 16. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Standard Error of Excess Return	87.88%		88.20%	
Annualized Geometric Mean Excess Return	17.94%		13.93%	
Information Ratio	66.30%		54.75%	
Tracking Error	10.53%		10.57%	
T-Score	2.202	*	1.913	*
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	17.95%		12.44%	
Standard Error of Excess Return	59.03%		57.54%	
Annualized Geometric Mean Excess Return	11.48%		7.69%	
Information Ratio	45.29%		35.57%	
Tracking Error	10.49%		10.00%	
T-Score	1.999	*	1.620	
EBIT-DA-Value				
Annualized Arithmetic Mean Excess Return	5.19%		-0.32%	
Standard Error of Excess Return	28.20%		38.02%	
Annualized Geometric Mean Excess Return	3.32%		-0.20%	
Information Ratio	20.16%		-5.74%	
Tracking Error	4.66%		4.45%	
T-Score	0.935		0.042	
Total MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	24.99%		19.48%	
Standard Error of Excess Return	109.81%		109.38%	
Annualized Geometric Mean Excess Return	15.99%		12.04%	
Information Ratio	49.51%		39.13%	
Tracking Error	11.57%		11.59%	
T-Score	1.685		1.465	
Free Float MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	26.57%		21.06%	
Standard Error of Excess Return	98.01%		98.95%	
Annualized Geometric Mean Excess Return	17.00%		13.01%	
Information Ratio	52.18%		41.74%	
Tracking Error	11.59%		11.63%	
T-Score	1.896	*	1.628	

Table 16. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Standard Deviation-Low Volatility				
Annualized Arithmetic Mean Excess Return	6.50%		0.99%	
Standard Error of Excess Return	39.69%		48.82%	
Annualized Geometric Mean Excess Return	4.16%		0.61%	
Information Ratio	12.36%		1.75%	
Tracking Error	11.14%		10.47%	
T-Score	0.956		0.270	
Beta-Low Volatility				
Annualized Arithmetic Mean Excess Return	19.35%		13.84%	
Standard Error of Excess Return	39.76%		37.93%	
Annualized Geometric Mean Excess Return	12.38%		8.55%	
Information Ratio	37.36%		27.15%	
Tracking Error	10.18%		9.61%	
T-Score	2.028	*	1.472	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	26.91%		21.39%	
Standard Error of Excess Return	59.03%		61.07%	
Annualized Geometric Mean Excess Return	17.21%		13.22%	
Information Ratio	54.87%		46.93%	
Tracking Error	12.49%		12.06%	
T-Score	2.622	**	2.129	*
ROE-Quality				
Annualized Arithmetic Mean Excess Return	10.15%		4.64%	
Standard Error of Excess Return	31.65%		34.14%	
Annualized Geometric Mean Excess Return	6.49%		2.86%	
Information Ratio	19.77%		8.67%	
Tracking Error	10.21%		9.51%	
T-Score	1.722		0.871	
Trailing Five-year Average Earnings Growth-Quality				
Annualized Arithmetic Mean Excess Return	-16.98%		-22.49%	
Standard Error of Excess Return	75.76%		83.26%	
Annualized Geometric Mean Excess Return	-10.86%		-13.90%	
Information Ratio	-21.00%		-28.42%	

Table 16. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Tracking Error	15.09%		15.35%
T-Score	-0.398		-0.660
Financial Leverage-Quality			
Annualized Arithmetic Mean Excess Return	18.08%		12.57%
Standard Error of Excess Return	35.90%		40.29%
Annualized Geometric Mean Excess Return	11.57%		7.77%
Information Ratio	53.46%		46.11%
Tracking Error	11.68%		10.95%
T-Score	2.306	**	1.439
Momentum-Momentum			
Annualized Arithmetic Mean Excess Return	7.33%		1.82%
Standard Error of Excess Return	39.25%		39.83%
Annualized Geometric Mean Excess Return	4.69%		1.13%
Information Ratio	33.33%		10.72%
Tracking Error	5.19%		4.99%
T-Score	1.035		0.398
Composite-Value			
Annualized Arithmetic Mean Excess Return	19.11%		13.59%
Standard Error of Excess Return	50.80%		52.92%
Annualized Geometric Mean Excess Return	12.22%		8.40%
Information Ratio	58.66%		43.67%
Tracking Error	7.20%		6.94%
T-Score	2.292	**	1.732
Composite-Small Size			
Annualized Arithmetic Mean Excess Return	26.19%		20.68%
Standard Error of Excess Return	103.63%		103.81%
Annualized Geometric Mean Excess Return	16.76%		12.78%
Information Ratio	51.91%		41.28%
Tracking Error	11.34%		11.37%
T-Score	1.801		1.559
Composite-Low Volatility			
Annualized Arithmetic Mean Excess Return	15.19%		9.67%
Standard Error of Excess Return	36.38%		40.22%

Table 16. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Annualized Geometric Mean Excess Return	9.71%		5.98%	
Information Ratio	29.27%		17.26%	
Tracking Error	8.85%		8.09%	
T-Score	1.940	*	1.139	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	26.91%		21.39%	
Standard Error of Excess Return	59.03%		61.07%	
Annualized Geometric Mean Excess Return	17.21%		13.22%	
Information Ratio	54.87%		46.93%	
Tracking Error	12.49%		12.06%	
T-Score	2.622	**	2.129	*
Composite-Quality				
Annualized Arithmetic Mean Excess Return	7.88%		2.37%	
Standard Error of Excess Return	46.14%		53.05%	
Annualized Geometric Mean Excess Return	5.04%		1.46%	
Information Ratio	20.39%		6.40%	
Tracking Error	8.33%		7.87%	
T-Score	1.087		0.478	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	7.33%		1.82%	
Standard Error of Excess Return	39.25%		39.83%	
Annualized Geometric Mean Excess Return	4.69%		1.13%	
Information Ratio	33.33%		10.72%	
Tracking Error	5.19%		4.99%	
T-Score	1.035		0.398	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	19.46%		13.95%	
Standard Error of Excess Return	47.28%		50.00%	
Annualized Geometric Mean Excess Return	12.45%		8.62%	
Information Ratio	54.64%		40.15%	
Tracking Error	7.01%		6.57%	
T-Score	2.280	*	1.661	

Note: * $p<0.90$, ** $p<0.95$, *** $p<0.99$.

Table 17. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Book to Price-Value				
Annualized Arithmetic Mean Excess Return	8.98%		5.95%	
Standard Error of Excess Return	14.50%		13.65%	
Annualized Geometric Mean Excess Return	7.83%		5.05%	
Information Ratio	37.93%		25.78%	
Tracking Error	5.11%		4.85%	
T-Score	2.596	**	1.875	*
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	9.41%		6.38%	
Standard Error of Excess Return	22.01%		21.75%	
Annualized Geometric Mean Excess Return	8.21%		5.42%	
Information Ratio	41.08%		30.43%	
Tracking Error	5.98%		5.81%	
T-Score	1.876	*	1.344	
EBIT-DA-Value				
Annualized Arithmetic Mean Excess Return	5.30%		2.27%	
Standard Error of Excess Return	8.07%		8.15%	
Annualized Geometric Mean Excess Return	4.62%		1.92%	
Information Ratio	51.03%		24.25%	
Tracking Error	2.42%		2.25%	
T-Score	2.626	**	1.124	
Total MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	4.76%		1.73%	
Standard Error of Excess Return	16.88%		16.27%	
Annualized Geometric Mean Excess Return	4.15%		1.47%	
Information Ratio	17.13%		5.77%	
Tracking Error	5.90%		5.59%	
T-Score	1.131		0.432	
Free Float MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	6.29%		3.26%	
Standard Error of Excess Return	18.90%		18.52%	
Annualized Geometric Mean Excess Return	5.49%		2.77%	
Information Ratio	23.53%		12.38%	
Tracking Error	5.87%		5.59%	

Table 17. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
T-Score	1.543		0.924	
Standard Deviation-Low Volatility				
Annualized Arithmetic Mean Excess Return	9.76%		6.73%	
Standard Error of Excess Return	10.30%		9.76%	
Annualized Geometric Mean Excess Return	8.51%		5.71%	
Information Ratio	53.94%		40.31%	
Tracking Error	3.94%		3.56%	
T-Score	4.040	***	3.029	***
Beta-Low Volatility				
Annualized Arithmetic Mean Excess Return	5.64%		2.60%	
Standard Error of Excess Return	18.58%		17.54%	
Annualized Geometric Mean Excess Return	4.91%		2.21%	
Information Ratio	17.86%		5.33%	
Tracking Error	5.37%		5.07%	
T-Score	1.118		0.497	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	15.31%		12.28%	
Standard Error of Excess Return	19.33%		20.04%	
Annualized Geometric Mean Excess Return	13.35%		10.43%	
Information Ratio	56.14%		47.07%	
Tracking Error	6.69%		6.52%	
T-Score	3.615	***	2.887	**
ROE-Quality				
Annualized Arithmetic Mean Excess Return	11.15%		8.12%	
Standard Error of Excess Return	49.09%		49.59%	
Annualized Geometric Mean Excess Return	9.72%		6.90%	
Information Ratio	37.29%		30.04%	
Tracking Error	9.06%		8.95%	
T-Score	1.248		0.992	
Trailing Five-year Average Earnings Growth-Quality				
Annualized Arithmetic Mean Excess Return	-3.65%		-6.68%	
Standard Error of Excess Return	21.65%		21.43%	

Table 17. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100		Total Return Index (XUTUM_CFNNTLTL)	
	June 2003-June 2019		June 2003-June 2019	
Annualized Geometric Mean Excess Return	-3.18%		-5.68%	
Information Ratio	-10.81%		-21.62%	
Tracking Error	6.75%		6.56%	
T-Score	-0.670		-1.239	
Financial Leverage-Quality				
Annualized Arithmetic Mean Excess Return	3.40%		0.36%	
Standard Error of Excess Return	11.33%		10.97%	
Annualized Geometric Mean Excess Return	2.96%		0.31%	
Information Ratio	22.58%		6.72%	
Tracking Error	4.26%		4.06%	
T-Score	1.194		0.134	
Momentum-Momentum				
Annualized Arithmetic Mean Excess Return	0.94%		-2.09%	
Standard Error of Excess Return	11.76%		11.15%	
Annualized Geometric Mean Excess Return	0.82%		-1.78%	
Information Ratio	-2.31%		-27.37%	
Tracking Error	2.98%		2.77%	
T-Score	0.034		-1.046	
Composite-Value				
Annualized Arithmetic Mean Excess Return	8.52%		5.49%	
Standard Error of Excess Return	11.59%		11.11%	
Annualized Geometric Mean Excess Return	7.43%		4.66%	
Information Ratio	51.90%		35.39%	
Tracking Error	3.62%		3.36%	
T-Score	2.964	***	2.008	*
Composite-Small Size				
Annualized Arithmetic Mean Excess Return	5.62%		2.59%	
Standard Error of Excess Return	17.11%		16.60%	
Annualized Geometric Mean Excess Return	4.90%		2.20%	
Information Ratio	20.76%		9.29%	
Tracking Error	5.76%		5.46%	
T-Score	1.410		0.728	
Composite-Low Volatility				

Table 17. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Annualized Arithmetic Mean Excess Return	7.96%		4.93%	
Standard Error of Excess Return	11.91%		10.79%	
Annualized Geometric Mean Excess Return	6.94%		4.18%	
Information Ratio	36.30%		21.98%	
Tracking Error	4.24%		3.88%	
T-Score	2.598	**	1.750	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	15.31%		12.28%	
Standard Error of Excess Return	19.33%		20.04%	
Annualized Geometric Mean Excess Return	13.35%		10.43%	
Information Ratio	56.14%		47.07%	
Tracking Error	6.69%		6.52%	
T-Score	3.615	***	2.887	**
Composite-Quality				
Annualized Arithmetic Mean Excess Return	4.87%		1.84%	
Standard Error of Excess Return	15.65%		15.91%	
Annualized Geometric Mean Excess Return	4.25%		1.56%	
Information Ratio	24.74%		11.07%	
Tracking Error	4.86%		4.65%	
T-Score	1.113		0.337	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	0.94%		-2.09%	
Standard Error of Excess Return	11.76%		11.15%	
Annualized Geometric Mean Excess Return	0.82%		-1.78%	
Information Ratio	-2.31%		-27.37%	
Tracking Error	2.98%		2.77%	
T-Score	0.034	*	-1.046	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	7.74%		4.70%	
Standard Error of Excess Return	5.86%		5.35%	
Annualized Geometric Mean Excess Return	6.74%		3.99%	
Information Ratio	43.71%		27.20%	
Tracking Error	3.62%		3.29%	
T-Score	5.023	***	3.246	***

Table 17. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019	Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019

Note: * p<0.90, ** p<0.95, *** p<0.99.

Table 18. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book to Price-Value				
Annualized Arithmetic Mean Excess Return	17.07%		12.77%	
Standard Error of Excess Return	58.82%		57.85%	
Annualized Geometric Mean Excess Return	12.84%		9.31%	
Information Ratio	50.08%		39.04%	
Tracking Error	7.60%		7.51%	
T-Score	2.510	**	2.126	**
Net Earnings to Price-Value				
Annualized Arithmetic Mean Excess Return	13.68%		9.38%	
Standard Error of Excess Return	41.04%		39.48%	
Annualized Geometric Mean Excess Return	10.29%		6.84%	
Information Ratio	41.62%		31.89%	
Tracking Error	7.95%		7.63%	
T-Score	2.548	**	2.025	*
EBIT-DA-Value				
Annualized Arithmetic Mean Excess Return	5.83%		1.53%	
Standard Error of Excess Return	17.83%		23.28%	
Annualized Geometric Mean Excess Return	4.39%		1.12%	
Information Ratio	32.92%		7.69%	
Tracking Error	3.42%		3.24%	
T-Score	1.844	*	0.354	
Total MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	12.74%		8.44%	
Standard Error of Excess Return	71.08%		69.89%	

Table 18. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Annualized Geometric Mean Excess Return	9.58%		6.15%	
Information Ratio	32.59%		22.59%	
Tracking Error	8.46%		8.34%	
T-Score	1.797	*	1.475	
Free Float MCAP-Small Size				
Annualized Arithmetic Mean Excess Return	14.48%		10.18%	
Standard Error of Excess Return	64.75%		64.26%	
Annualized Geometric Mean Excess Return	10.89%		7.42%	
Information Ratio	36.76%		26.74%	
Tracking Error	8.46%		8.35%	
T-Score	2.104	**	1.736	*
Standard Deviation-Low Volatility				
Annualized Arithmetic Mean Excess Return	9.57%		5.27%	
Standard Error of Excess Return	24.73%		29.76%	
Annualized Geometric Mean Excess Return	7.20%		3.84%	
Information Ratio	24.79%		13.96%	
Tracking Error	7.45%		6.95%	
T-Score	2.270	**	1.058	
Beta-Low Volatility				
Annualized Arithmetic Mean Excess Return	11.37%		7.07%	
Standard Error of Excess Return	29.34%		27.31%	
Annualized Geometric Mean Excess Return	8.55%		5.15%	
Information Ratio	26.78%		16.03%	
Tracking Error	7.51%		7.09%	
T-Score	2.234	**	1.498	
Gross Dividend Yield-High Yield				
Annualized Arithmetic Mean Excess Return	21.44%		17.14%	
Standard Error of Excess Return	41.04%		41.42%	
Annualized Geometric Mean Excess Return	16.13%		12.49%	
Information Ratio	52.94%		44.92%	
Tracking Error	9.26%		8.97%	
T-Score	3.647	***	3.019	***
ROE-Quality				

Table 18. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019
Annualized Arithmetic Mean Excess Return	12.00%		7.69%
Standard Error of Excess Return	42.79%		43.80%
Annualized Geometric Mean Excess Return	9.02%		5.61%
Information Ratio	30.30%		21.84%
Tracking Error	9.49%		9.15%
T-Score	1.911	*	1.304
Trailing Five-year Average Earnings Growth-Quality			
Annualized Arithmetic Mean Excess Return	-9.17%		-13.47%
Standard Error of Excess Return	47.79%		52.07%
Annualized Geometric Mean Excess Return	-6.90%		-9.81%
Information Ratio	-15.39%		-23.49%
Tracking Error	10.61%		10.68%
T-Score	-0.625		-1.047
Financial Leverage-Quality			
Annualized Arithmetic Mean Excess Return	9.22%		4.92%
Standard Error of Excess Return	25.53%		26.72%
Annualized Geometric Mean Excess Return	6.93%		3.58%
Information Ratio	37.00%		27.54%
Tracking Error	7.89%		7.41%
T-Score	2.393	**	1.364
Momentum-Momentum			
Annualized Arithmetic Mean Excess Return	3.44%		-0.86%
Standard Error of Excess Return	25.64%		25.31%
Annualized Geometric Mean Excess Return	2.58%		-0.63%
Information Ratio	15.13%		-7.45%
Tracking Error	3.95%		3.74%
T-Score	0.976		0.015
Composite-Value			
Annualized Arithmetic Mean Excess Return	13.45%		9.15%
Standard Error of Excess Return	34.24%		34.35%
Annualized Geometric Mean Excess Return	10.12%		6.67%
Information Ratio	52.43%		37.49%
Tracking Error	5.24%		4.99%

Table 18. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
T-Score	2.866	***	2.139	**
Composite-Small Size				
Annualized Arithmetic Mean Excess Return	13.83%		9.53%	
Standard Error of Excess Return	67.69%		66.81%	
Annualized Geometric Mean Excess Return	10.41%		6.95%	
Information Ratio	35.40%		25.20%	
Tracking Error	8.29%		8.17%	
T-Score	1.961	*	1.618	
Composite-Low Volatility				
Annualized Arithmetic Mean Excess Return	11.57%		7.27%	
Standard Error of Excess Return	24.46%		25.60%	
Annualized Geometric Mean Excess Return	8.70%		5.30%	
Information Ratio	30.43%		18.19%	
Tracking Error	6.34%		5.79%	
T-Score	2.759	**	1.674	
Composite-High Yield				
Annualized Arithmetic Mean Excess Return	21.44%		17.14%	
Standard Error of Excess Return	41.04%		41.42%	
Annualized Geometric Mean Excess Return	16.13%		12.49%	
Information Ratio	52.94%		44.92%	
Tracking Error	9.26%		8.97%	
T-Score	3.647	***	3.019	***
Composite-Quality				
Annualized Arithmetic Mean Excess Return	6.54%		2.24%	
Standard Error of Excess Return	30.33%		33.78%	
Annualized Geometric Mean Excess Return	4.92%		1.63%	
Information Ratio	21.81%		8.46%	
Tracking Error	6.36%		6.03%	
T-Score	1.462		0.583	
Composite-Momentum				
Annualized Arithmetic Mean Excess Return	3.44%		-0.86%	
Standard Error of Excess Return	25.64%		25.31%	
Annualized Geometric Mean Excess Return	2.58%		-0.63%	

Table 18. Annualized Excess Returns over Market Proxy-(Portfolio Return - R_m) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Information Ratio	15.13%		-7.45%	
Tracking Error	3.95%		3.74%	
T-Score	0.976	*	0.015	
Composite-All Factors				
Annualized Arithmetic Mean Excess Return	12.99%		8.69%	
Standard Error of Excess Return	31.16%		31.63%	
Annualized Geometric Mean Excess Return	9.77%		6.33%	
Information Ratio	46.97%		32.29%	
Tracking Error	5.14%		4.77%	
T-Score	2.855	***	2.034	*

Note: * p<0.90, ** p<0.95, *** p<0.99.

5.7 Jensen's alpha for AHM-fundamental indexation portfolios

Table 19, Table 20 and Table 21 show the AHM-Fundamental indexation model's alpha generation potential and the model's strength in terms of statistical significance. Apart from the "Trailing Five-year Average Gross Dividends" and the "Trailing Five-year Average Cash Flow" fundamental indexation risk factors, all the remaining fundamental risk factors as well as the composite risk factor generated positive Jensen's alpha within the 95% confidence interval and above in both sub-periods and the entire analysis period of June 1993-June 2019. Alpha for "Trailing Five-year Average Cash Flow" is not statistically significant (for both market proxies) in the June 1993-June 2002 sub-period and the entire analysis period of June 1993-June 2019. If we substitute BIST-100 as the reference market portfolio, alpha for "Trailing Five-year Average Cash Flow" becomes significant within a 95% confidence interval. On the other hand, alpha for "Trailing Five-year Average Gross

Dividends" was not statistically significant at a 95% confidence level in the sub-period of June 2003-June 2019. Like former examples, alpha for "Trailing Five-year Average Gross Dividends" becomes statistically significant within a 95% confidence interval if we substitute BIST-100 as the reference market portfolio.

Table 19. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Book Value				
α_i-Alpha	0.015735		0.012196	
(t Stat.)	3.077482		2.577404	
(P Value)	0.002596	***	0.011186	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.031236		1.036997	
(t Stat.)	38.467941		41.785258	
(P Value)	0.000000		0.000000	
R^2	0.926148		0.936696	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Net Sales				
α_i-Alpha	0.015649		0.012214	
(t Stat.)	2.612959		2.191446	
(P Value)	0.010144	**	0.030384	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.002323		1.009927	
(t Stat.)	31.920782		34.547448	
(P Value)	0.000000		0.000000	
R^2	0.896212		0.910028	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Gross Dividends				
α_i-Alpha	0.011181		0.007836	
(t Stat.)	2.420767		2.070580	
(P Value)	0.017012	**	0.040579	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.979718		0.991149	
(t Stat.)	40.455151		49.935111	
(P Value)	0.000000		0.000000	
R^2	0.932749		0.954816	
Significance-F	0.000000		0.000000	

Table 19. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Trailing Five-year Average Cash Flow				
α_i-Alpha	0.007500		0.004176	
(t Stat.)	1.264078		0.749022	
(P Value)	0.208693		0.455334	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.969508		0.976235	
(t Stat.)	31.164932		33.382497	
(P Value)	0.000000		0.000000	
R^2	0.891669		0.904251	
Significance-F	0.000000		0.000000	
Composite-AHM				
α_i-Alpha	0.012516		0.009106	
(t Stat.)	2.621608		2.154318	
(P Value)	0.009904	***	0.033248	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.995696		1.003577	
(t Stat.)	39.776881		45.270979	
(P Value)	0.000000		0.000000	
R^2	0.930596		0.945558	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 20. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Book Value				
α_i-Alpha	0.004003		0.001842	
(t Stat.)	4.030196		2.085966	
(P Value)	0.000079	***	0.038237	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.003477		1.037959	
(t Stat.)	84.677139		95.626338	
(P Value)	0.000000		0.000000	
R^2	0.972600		0.978387	
Significance-F	0.000000		0.000000	

Table 20. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Trailing Five-year Average Net Sales				
α_i-Alpha	0.005131		0.003062	
(t Stat.)	3.759579		2.465763	
(P Value)	0.000223	***	0.014506	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.956316		0.991265	
(t Stat.)	58.728302		64.954793	
(P Value)	0.000000		0.000000	
R^2	0.944673		0.954310	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Gross Dividends				
α_i-Alpha	0.006753		0.004640	
(t Stat.)	2.222167		1.554886	
(P Value)	0.027381	**	0.121539	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.975820		1.011658	
(t Stat.)	26.916334		27.585061	
(P Value)	0.000000		0.000000	
R^2	0.781973		0.790225	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Cash Flow				
α_i-Alpha	0.004864		0.002920	
(t Stat.)	3.176627		2.056945	
(P Value)	0.001724	***	0.040976	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.896844		0.930434	
(t Stat.)	49.093103		53.343226	
(P Value)	0.000000		0.000000	
R^2	0.922669		0.933716	
Significance-F	0.000000		0.000000	
Composite-AHM				
α_i-Alpha	0.005188		0.003116	
(t Stat.)	3.880590		2.557444	
(P Value)	0.000141	***	0.011278	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.958114		0.992829	
(t Stat.)	60.071789		66.306611	
(P Value)	0.000000		0.000000	
R^2	0.946990		0.956073	
Significance-F	0.000000		0.000000	

Table 20. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 21. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book Value				
α_i-Alpha	0.008294		0.005682	
(t Stat.)	4.125604		3.070673	
(P Value)	0.000047	***	0.002318	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.022966		1.036163	
(t Stat.)	68.073766		74.363511	
(P Value)	0.000000		0.000000	
R^2	0.935029		0.944975	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Net Sales				
α_i-Alpha	0.008937		0.006405	
(t Stat.)	3.743239		2.897136	
(P Value)	0.000215	***	0.004024	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.989686		1.004582	
(t Stat.)	55.455301		60.335232	
(P Value)	0.000000		0.000000	
R^2	0.905219		0.918735	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Gross Dividends				
α_i-Alpha	0.008385		0.005878	
(t Stat.)	3.276317		2.515084	
(P Value)	0.001166	***	0.012387	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.978223		0.995665	
(t Stat.)	51.132988		56.576273	
(P Value)	0.000000		0.000000	
R^2	0.890349		0.908597	
Significance-F	0.000000		0.000000	

Table 21. Monthly Jensen's Alpha-(αi) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Trailing Five-year Average Cash Flow				
α_i-Alpha	0.005700		0.003267	
(t Stat.)	2.375256		1.455939	
(P Value)	0.018122	**	0.146384	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.951226		0.965290	
(t Stat.)	53.032657		57.126232	
(P Value)	0.000000		0.000000	
R^2	0.897271		0.910191	
Significance-F	0.000000		0.000000	
Composite-AHM				
α_i-Alpha	0.007829		0.005308	
(t Stat.)	3.990376		3.046008	
(P Value)	0.000082	***	0.002511	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.985525		1.000425	
(t Stat.)	67.200138		76.236357	
(P Value)	0.000000		0.000000	
R^2	0.933442		0.947506	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

5.8 Jensen's alpha for factor investing portfolios

5.8.1 Jensen's alpha for factor investing portfolios constructed according to the median breakpoint

Table 22, Table 23 and Table 24 show the median breakpoint factor investing portfolios' alpha generation potential and the model's strength in terms of statistical significance. In terms of statistical significance, the June 1993-June 2002 sub-period turns out to be disappointing. There is no statistically significant alpha for factor

investing portfolios within the 95% confidence interval. Perhaps this is due to the adverse macroeconomic conditions and excessive volatility in financial markets prevalent in this period. The entire analysis period of June 1993-June 2019 also suffers from the spillover effect from the earlier sub-period of June 1993-June 2002. Only the alphas for "Book to Price" and "Gross Dividend Yield" were statistically significant in this period. The sub-period of June 2003-June 2019 proved to be another dismal performance. The number of statistically significant alphas stayed the same, but the composition changed to replace "Book to Price" with "Standard Deviation ."Similar to the earlier examples, substituting BIST-100 as the reference market portfolio changes the picture dramatically. In the sub-period of June 2003-June 2019, the number of statistically significant alphas increased from two to five, and even three became significant within a 99% confidence interval. This unaccounted increase in statistical significance is another stark example of how academic work can be misleading if the sample's return characteristics, i.e., total return approach, and the population's thereof mismatch.

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Book to Price-Value				
α_i-Alpha	0.021033		0.017725	
(t Stat.)	2.216794		1.865747	
(P Value)	0.028554	**	0.064560	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.958913		0.958310	
(t Stat.)	19.275831		19.232911	
(P Value)	0.000000		0.000000	
R^2	0.758966		0.758150	
Significance-F	0.000000		0.000000	

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Net Earnings to Price-Value		
α_i-Alpha	0.011673	0.008473
(t Stat.)	1.448295	1.092694
(P Value)	0.150186	0.276754
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.934835	0.943010
(t Stat.)	22.122656	23.188151
(P Value)	0.000000	0.000000
R^2	0.805733	0.820037
Significance-F	0.000000	0.000000
EBIT-DA-Value		
α_i-Alpha	0.002192	-0.001033
(t Stat.)	0.492196	-0.253508
(P Value)	0.623496	0.800316
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.939686	0.945155
(t Stat.)	40.242232	44.240113
(P Value)	0.000000	0.000000
R^2	0.932084	0.943138
Significance-F	0.000000	0.000000
Total MCAP-Small Size		
α_i-Alpha	0.011778	0.008827
(t Stat.)	1.096137	0.853455
(P Value)	0.275251	0.395136
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.868593	0.884025
(t Stat.)	15.417782	16.295823
(P Value)	0.000000	0.000000
R^2	0.668267	0.692351
Significance-F	0.000000	0.000000
Free Float MCAP-Small Size		
α_i-Alpha	0.010214	0.007098
(t Stat.)	1.180289	0.813666
(P Value)	0.240259	0.417475
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.901619	0.899240
(t Stat.)	19.871251	19.654039
(P Value)	0.000000	0.000000
R^2	0.769921	0.766004
Significance-F	0.000000	0.000000

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Standard Deviation-Low Volatility		
α_i-Alpha	0.004445	0.001435
(t Stat.)	0.624175	0.211344
(P Value)	0.533717	0.832984
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.879545	0.887794
(t Stat.)	23.558406	24.923131
(P Value)	0.000000	0.000000
R^2	0.824665	0.840360
Significance-F	0.000000	0.000000
Beta-Low Volatility		
α_i-Alpha	0.008263	0.005311
(t Stat.)	1.316097	0.941912
(P Value)	0.190692	0.348162
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.867754	0.881756
(t Stat.)	26.360516	29.814536
(P Value)	0.000000	0.000000
R^2	0.854837	0.882809
Significance-F	0.000000	0.000000
Gross Dividend Yield-High Yield		
α_i-Alpha	0.017668	0.014546
(t Stat.)	1.818110	1.551754
(P Value)	0.071584 *	0.123399
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.914791	0.926135
(t Stat.)	17.954638	18.837414
(P Value)	0.000000	0.000000
R^2	0.732043	0.750448
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.005109	0.002172
(t Stat.)	0.706117	0.322654
(P Value)	0.481507	0.747528
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.862376	0.875315
(t Stat.)	22.733329	24.786812
(P Value)	0.000000	0.000000
R^2	0.814116	0.838883
Significance-F	0.000000	0.000000

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Trailing Five-Year Average Earnings Growth-Quality			
α_i-Alpha	-0.010598		-0.013445
(t Stat.)	-0.802421		-1.002299
(P Value)	0.423923		0.318250
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.816098		0.804678
(t Stat.)	11.785151		11.436924
(P Value)	0.000000		0.000000
R^2	0.540659		0.525730
Significance-F	0.000000		0.000000
Financial Leverage-Quality			
α_i-Alpha	0.018383		0.014803
(t Stat.)	1.723615		1.488987
(P Value)	0.087397	*	0.139159
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.056872		1.079281
(t Stat.)	18.899736		20.697881
(P Value)	0.000000		0.000000
R^2	0.751684		0.784042
Significance-F	0.000000		0.000000
Momentum-Momentum			
α_i-Alpha	0.006362		0.002994
(t Stat.)	1.657165		0.907152
(P Value)	0.100143		0.366175
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.981869		0.988094
(t Stat.)	48.778317		57.076559
(P Value)	0.000000		0.000000
R^2	0.952749		0.965045
Significance-F	0.000000		0.000000
Composite-Value			
α_i-Alpha	0.011633		0.008388
(t Stat.)	1.785784		1.329453
(P Value)	0.076703	*	0.186263
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.944478		0.948825
(t Stat.)	27.653924		28.671823
(P Value)	0.000000		0.000000
R^2	0.866325		0.874478

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
Significance-F	0.000000	0.000000
Composite-Small Size		
α_i-Alpha	0.010996	0.007963
(t Stat.)	1.219337	0.903696
(P Value)	0.225148	0.367998
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.885106	0.891633
(t Stat.)	18.719551	19.293572
(P Value)	0.000000	0.000000
R^2	0.748090	0.759303
Significance-F	0.000000	0.000000
Composite-Low Volatility		
α_i-Alpha	0.004956	0.001888
(t Stat.)	1.062605	0.476195
(P Value)	0.290131	0.634816
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.898920	0.909653
(t Stat.)	36.756582	43.753393
(P Value)	0.000000	0.000000
R^2	0.919676	0.941939
Significance-F	0.000000	0.000000
Composite-High Yield		
α_i-Alpha	0.017668	0.014546
(t Stat.)	1.818110	1.551754
(P Value)	0.071584 *	0.123399
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.914791	0.926135
(t Stat.)	17.954638	18.837414
(P Value)	0.000000	0.000000
R^2	0.732043	0.750448
Significance-F	0.000000	0.000000
Composite-Quality		
α_i-Alpha	0.004298	0.001177
(t Stat.)	0.596143	0.170955
(P Value)	0.552222	0.864552
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.911782	0.919758
(t Stat.)	24.120553	25.474595
(P Value)	0.000000	0.000000
R^2	0.831381	0.846145

Table 22. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.006362		0.002994	
(t Stat.)	1.657165		0.907152	
(P Value)	0.100143		0.366175	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.981869		0.988094	
(t Stat.)	48.778317		57.076559	
(P Value)	0.000000		0.000000	
R^2	0.952749		0.965045	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.009319		0.006159	
(t Stat.)	1.671631		1.196139	
(P Value)	0.097247	*	0.234040	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.922824		0.930683	
(t Stat.)	31.572677		34.460416	
(P Value)	0.000000		0.000000	
R^2	0.894155		0.909615	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Book to Price-Value				
α_i-Alpha	0.006984		0.005368	
(t Stat.)	2.433248		1.934895	
(P Value)	0.015834	**	0.054400	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.730043		0.764173	
(t Stat.)	21.320148		22.414354	
(P Value)	0.000000		0.000000	
R^2	0.692331		0.713232	

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Significance-F	0.000000		0.000000	
Net Earnings to Price-Value				
α_i-Alpha	0.008023		0.006262	
(t Stat.)	2.249082		1.797585	
(P Value)	0.025586	**	0.073736	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.797703		0.834124	
(t Stat.)	18.743826		19.485885	
(P Value)	0.000000		0.000000	
R^2	0.634938		0.652742	
Significance-F	0.000000		0.000000	
EBIT-DA-Value				
α_i-Alpha	0.004194		0.002199	
(t Stat.)	2.765432		1.558139	
(P Value)	0.006212	***	0.120766	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.921122		0.954954	
(t Stat.)	50.915212		55.049758	
(P Value)	0.000000		0.000000	
R^2	0.927712		0.937509	
Significance-F	0.000000		0.000000	
Total MCAP-Small Size				
α_i-Alpha	0.002512		0.000863	
(t Stat.)	0.807904		0.291860	
(P Value)	0.420096		0.770693	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.728065		0.769922	
(t Stat.)	19.623565		21.187620	
(P Value)	0.000000		0.000000	
R^2	0.655927		0.689668	
Significance-F	0.000000		0.000000	
Free Float MCAP-Small Size				
α_i-Alpha	0.004288		0.002668	
(t Stat.)	1.331702		0.865298	
(P Value)	0.184459		0.387902	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.716591		0.757131	
(t Stat.)	18.655012		19.985473	
(P Value)	0.000000		0.000000	
R^2	0.632734		0.664128	

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Significance-F	0.000000		0.000000	
Standard Deviation-Low Volatility				
α_i-Alpha	0.006660		0.004875	
(t Stat.)	2.654254		2.077828	
(P Value)	0.008581	***	0.038989	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.800897		0.840690	
(t Stat.)	26.755784		29.154810	
(P Value)	0.000000		0.000000	
R^2	0.779926		0.807985	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.002783		0.001312	
(t Stat.)	1.102836		0.542195	
(P Value)	0.271410		0.588282	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.661393		0.693797	
(t Stat.)	21.966471		23.328543	
(P Value)	0.000000		0.000000	
R^2	0.704905		0.729303	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.011208		0.009415	
(t Stat.)	2.777776		2.380291	
(P Value)	0.005989	***	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.811032		0.848663	
(t Stat.)	16.847736		17.460144	
(P Value)	0.000000		0.000000	
R^2	0.584231		0.601465	
Significance-F	0.000000		0.000000	
ROE-Quality				
α_i-Alpha	0.010137		0.008305	
(t Stat.)	1.748245		1.442412	
(P Value)	0.081941		0.150735	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.834660		0.870485	
(t Stat.)	12.065991		12.302892	
(P Value)	0.000000		0.000000	
R^2	0.418852		0.428347	

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Significance-F	0.000000		0.000000	
Trailing Five-Year Average Earnings Growth-Quality				
α_i-Alpha	-0.000973		-0.002675	
(t Stat.)	-0.220636		-0.616116	
(P Value)	0.825599		0.538512	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.767869		0.804227	
(t Stat.)	14.595492		15.074105	
(P Value)	0.000000		0.000000	
R^2	0.513286		0.529388	
Significance-F	0.000000		0.000000	
Financial Leverage-Quality				
α_i-Alpha	0.002694		0.000696	
(t Stat.)	0.911869		0.243909	
(P Value)	0.362925		0.807549	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.912040		0.950415	
(t Stat.)	25.876715		27.108208	
(P Value)	0.000000		0.000000	
R^2	0.768243		0.784385	
Significance-F	0.000000		0.000000	
Momentum-Momentum				
α_i-Alpha	0.002296		0.000363	
(t Stat.)	1.950334		0.322047	
(P Value)	0.052520	*	0.747750	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.899224		0.929264	
(t Stat.)	64.037231		67.012364	
(P Value)	0.000000		0.000000	
R^2	0.953053		0.956954	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.006400		0.004610	
(t Stat.)	2.960636		2.257032	
(P Value)	0.003437	***	0.025076	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.816289		0.851084	
(t Stat.)	31.651146		33.909797	

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.832197		0.850578	
Significance-F	0.000000		0.000000	
Composite-Small Size				
α_i-Alpha	0.003400		0.001765	
(t Stat.)	1.091497		0.594809	
(P Value)	0.276354		0.552637	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.722328		0.763526	
(t Stat.)	19.436214		20.935084	
(P Value)	0.000000		0.000000	
R^2	0.651584		0.684512	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.002762		0.001019	
(t Stat.)	1.718922		0.687017	
(P Value)	0.087161	*	0.492860	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.798537		0.830638	
(t Stat.)	41.662395		45.551965	
(P Value)	0.000000		0.000000	
R^2	0.895756		0.911286	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.011208		0.009415	
(t Stat.)	2.777776		2.380291	
(P Value)	0.005989	***	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.811032		0.848663	
(t Stat.)	16.847736		17.460144	
(P Value)	0.000000		0.000000	
R^2	0.584231		0.601465	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.003953		0.002109	
(t Stat.)	1.256346		0.690843	
(P Value)	0.210442		0.490457	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.838190		0.875042	
(t Stat.)	22.331663		23.329065	

Table 23. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.711718		0.729312	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.002296		0.000363	
(t Stat.)	1.950334		0.322047	
(P Value)	0.052520	*	0.747750	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.899224		0.929264	
(t Stat.)	64.037231		67.012364	
(P Value)	0.000000		0.000000	
R^2	0.953053		0.956954	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.005003		0.003213	
(t Stat.)	2.634062		1.835492	
(P Value)	0.009090	***	0.067903	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.814267		0.849703	
(t Stat.)	35.934039		39.493570	
(P Value)	0.000000		0.000000	
R^2	0.864725		0.885341	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book to Price-Value				
α_i-Alpha	0.011743		0.009445	
(t Stat.)	2.922764		2.378256	
(P Value)	0.003715	***	0.017978	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.900642		0.911197	
(t Stat.)	29.988777		30.467028	

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.736352		0.742449	
Significance-F	0.000000		0.000000	
Net Earnings to Price-Value				
α_i-Alpha	0.009109		0.006799	
(t Stat.)	2.431678		1.881596	
(P Value)	0.015574	**	0.060793	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.900493		0.917070	
(t Stat.)	32.159905		33.699497	
(P Value)	0.000000		0.000000	
R^2	0.762582		0.779097	
Significance-F	0.000000		0.000000	
EBIT-DA-Value				
α_i-Alpha	0.003416		0.001027	
(t Stat.)	1.799897		0.588581	
(P Value)	0.072813	*	0.556555	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.935337		0.947800	
(t Stat.)	65.922288		72.124448	
(P Value)	0.000000		0.000000	
R^2	0.931016		0.941708	
Significance-F	0.000000		0.000000	
Total MCAP-Small Size				
α_i-Alpha	0.005671		0.003519	
(t Stat.)	1.276575		0.826308	
(P Value)	0.202672		0.409241	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.832738		0.856263	
(t Stat.)	25.076294		26.695968	
(P Value)	0.000000		0.000000	
R^2	0.661345		0.688791	
Significance-F	0.000000		0.000000	
Free Float MCAP-Small Size				
α_i-Alpha	0.006124		0.003942	
(t Stat.)	1.601371		1.042914	
(P Value)	0.110275		0.297771	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.855162		0.865227	
(t Stat.)	29.916370		30.397507	

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.735413		0.741575	
Significance-F	0.000000		0.000000	
Standard Deviation-Low Volatility				
α_i-Alpha	0.005687		0.003479	
(t Stat.)	1.852378		1.196229	
(P Value)	0.064887	*	0.232487	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.860366		0.877023	
(t Stat.)	37.490177		40.044916	
(P Value)	0.000000		0.000000	
R^2	0.813605		0.832779	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.004413		0.002308	
(t Stat.)	1.529796		0.873342	
(P Value)	0.127049		0.383128	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.816076		0.836959	
(t Stat.)	37.849150		42.052921	
(P Value)	0.000000		0.000000	
R^2	0.816478		0.845966	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.013399		0.011116	
(t Stat.)	3.044617		2.608128	
(P Value)	0.002522	***	0.009528	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.888363		0.907314	
(t Stat.)	27.004147		28.268852	
(P Value)	0.000000		0.000000	
R^2	0.693690		0.712789	
Significance-F	0.000000		0.000000	
ROE-Quality				
α_i-Alpha	0.008221		0.006020	
(t Stat.)	1.820771		1.372750	
(P Value)	0.069570		0.170786	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.856127		0.874802	
(t Stat.)	25.365651		26.489994	

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.666465		0.685461	
Significance-F	0.000000		0.000000	
Trailing Five-Year Average Earnings Growth-Quality				
α_i-Alpha	-0.004631		-0.006667	
(t Stat.)	-0.826201		-1.179956	
(P Value)	0.409302		0.238889	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.805329		0.805675	
(t Stat.)	19.222340		18.933856	
(P Value)	0.000000		0.000000	
R^2	0.534345		0.526812	
Significance-F	0.000000		0.000000	
Financial Leverage-Quality				
α_i-Alpha	0.008223		0.005591	
(t Stat.)	1.873605		1.358488	
(P Value)	0.061890	*	0.175260	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.019181		1.047403	
(t Stat.)	31.065761		33.796859	
(P Value)	0.000000		0.000000	
R^2	0.749822		0.780089	
Significance-F	0.000000		0.000000	
Momentum-Momentum				
α_i-Alpha	0.003641		0.001186	
(t Stat.)	2.246298		0.834657	
(P Value)	0.025362	**	0.404530	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.960948		0.973931	
(t Stat.)	79.304138		90.999736	
(P Value)	0.000000		0.000000	
R^2	0.951294		0.962571	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.008089		0.005757	
(t Stat.)	2.898911		2.152830	
(P Value)	0.004002	***	0.032075	**

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100		Total Return Index (XUTUM_CFNNTLTL)	
	June 1993-June 2019		June 1993-June 2019	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.912157		0.925356	
(t Stat.)	43.729883		45.948683	
(P Value)	0.000000		0.000000	
R^2	0.855883		0.867668	
Significance-F	0.000000		0.000000	
Composite-Small Size				
α_i-Alpha	0.005898		0.003731	
(t Stat.)	1.514122		0.990075	
(P Value)	0.130976		0.322881	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.843950		0.860745	
(t Stat.)	28.986545		30.333542	
(P Value)	0.000000		0.000000	
R^2	0.722944		0.740767	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.003380		0.002893	
(t Stat.)	1.674108		1.160954	
(P Value)	0.095080	*	0.246521	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.873839		0.856991	
(t Stat.)	57.903884		45.659506	
(P Value)	0.000000		0.000000	
R^2	0.912378		0.866212	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.013399		0.011116	
(t Stat.)	3.044617		2.608128	
(P Value)	0.002522	***	0.009528	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.888363		0.907314	
(t Stat.)	27.004147		28.268852	
(P Value)	0.000000		0.000000	
R^2	0.693690		0.712789	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.003938		0.001648	
(t Stat.)	1.186861		0.517967	
(P Value)	0.236157		0.604837	

Table 24. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - Median Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.893546		0.909294	
(t Stat.)	36.028094		37.957055	
(P Value)	0.000000		0.000000	
R^2	0.801237		0.817330	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.003641		0.001186	
(t Stat.)	2.246298		0.834657	
(P Value)	0.025362	**	0.404530	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.960948		0.973931	
(t Stat.)	79.304138		90.999736	
(P Value)	0.000000		0.000000	
R^2	0.951294		0.962571	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.006391		0.004096	
(t Stat.)	2.660004		1.854535	
(P Value)	0.008205	***	0.064577	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.895467		0.911257	
(t Stat.)	49.860933		54.790853	
(P Value)	0.000000		0.000000	
R^2	0.885332		0.903130	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

5.8.2 Jensen's alpha for factor investing portfolios constructed according to the 30th percentile breakpoint

Table 25, Table 26 and Table 27 show the 30th percentile breakpoint factor investing portfolios' alpha generation potential and the model's strength in terms of statistical significance. In terms of statistical significance, the June 1993-June 2002 sub-period turns out to be disappointing, similar to the case in median breakpoint alphas. There

is no statistically significant alpha for factor investing portfolios within the 95% confidence interval. This dismal performance is probably due to the adverse macroeconomic conditions and excessive volatility in financial markets prevalent in this period. The June 1993-June 2019 period also suffers from the ripple effects of the earlier sub-period of June 1993-June 2002. Only the alphas for "Book to Price" and "Gross Dividend Yield" were statistically significant in this period. The sub-period of June 2003-June 2019 proved to be another negative performance. The number of statistically significant alphas stayed the same, but the composition changed to replace "Book to Price" with "Standard Deviation ." Like the former examples, substituting BIST-100 as the reference market portfolio changes the picture dramatically. In the sub-period of June 2003-June 2019, the statistically significant alphas increased from two to four, but no alphas this time became significant within a 99% confidence interval like the median breakpoint.

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002	
Book to Price-Value				
α_i-Alpha	0.019890		0.016584	
(t Stat.)	2.065092		1.716316	
(P Value)	0.041105	**	0.088728	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.957753		0.956520	
(t Stat.)	18.965692		18.874328	
(P Value)	0.000000		0.000000	
R^2	0.752982		0.751181	
Significance-F	0.000000		0.000000	
Net Earnings to Price-Value				
α_i-Alpha	0.013325		0.010130	
(t Stat.)	1.393324		1.109566	
(P Value)	0.166141		0.269442	

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100	Total Return Index (XUTUM_CFNNTLTL)
	June 1993-June 2002	June 1993-June 2002
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.938086	0.951799
(t Stat.)	18.708778	19.877871
(P Value)	0.000000	0.000000
R^2	0.747873	0.770039
Significance-F	0.000000	0.000000
EBIT-DA-Value		
α_i-Alpha	0.002398	-0.000873
(t Stat.)	0.573153	-0.218547
(P Value)	0.567632	0.827380
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.950710	0.953256
(t Stat.)	43.333237	45.508366
(P Value)	0.000000	0.000000
R^2	0.940875	0.946094
Significance-F	0.000000	0.000000
Total MCAP-Small Size		
α_i-Alpha	0.015706	0.012710
(t Stat.)	1.515811	1.225575
(P Value)	0.132241	0.222799
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.868393	0.867795
(t Stat.)	15.985018	15.954848
(P Value)	0.000000	0.000000
R^2	0.684087	0.683270
Significance-F	0.000000	0.000000
Free Float MCAP-Small Size		
α_i-Alpha	0.016664	0.013644
(t Stat.)	1.602179	1.308636
(P Value)	0.111790	0.193201
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.874632	0.873390
(t Stat.)	16.038636	15.971208
(P Value)	0.000000	0.000000
R^2	0.685533	0.683714
Significance-F	0.000000	0.000000
Standard Deviation-Low Volatility		
α_i-Alpha	0.002895	0.000092
(t Stat.)	0.296182	0.009984

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002	Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
(P Value)	0.767612	0.992051
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.829387	0.849272
(t Stat.)	16.185681	17.551632
(P Value)	0.000000	0.000000
R^2	0.689454	0.723044
Significance-F	0.000000	0.000000
Beta-Low Volatility		
α_i-Alpha	0.009870	0.007068
(t Stat.)	1.119357	0.846301
(P Value)	0.265261	0.399098
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.825314	0.840678
(t Stat.)	17.852026	19.191148
(P Value)	0.000000	0.000000
R^2	0.729788	0.757352
Significance-F	0.000000	0.000000
Gross Dividend Yield-High Yield		
α_i-Alpha	0.019177	0.016100
(t Stat.)	1.692042	1.468630
(P Value)	0.093277 *	0.144594
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.904406	0.918854
(t Stat.)	15.220147	15.981214
(P Value)	0.000000	0.000000
R^2	0.662522	0.683984
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.004772	0.001953
(t Stat.)	0.536332	0.234649
(P Value)	0.592739	0.814888
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.833468	0.852353
(t Stat.)	17.865160	19.527413
(P Value)	0.000000	0.000000
R^2	0.730078	0.763679
Significance-F	0.000000	0.000000
Trailing Five-Year Average Earnings Growth-Quality		
α_i-Alpha	-0.010304	-0.013156

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
(t Stat.)	-0.765383		-0.963109
(P Value)	0.445572		0.337463
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.817756		0.806652
(t Stat.)	11.585423		11.258871
(P Value)	0.000000		0.000000
R^2	0.532158		0.517899
Significance-F	0.000000		0.000000
Financial Leverage-Quality			
α_i-Alpha	0.018383		0.014803
(t Stat.)	1.723587		1.488953
(P Value)	0.087402	*	0.139168
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.056874		1.079282
(t Stat.)	18.899467		20.697435
(P Value)	0.000000		0.000000
R^2	0.751678		0.784035
Significance-F	0.000000		0.000000
Momentum-Momentum			
α_i-Alpha	0.004814		0.001470
(t Stat.)	1.016999		0.322960
(P Value)	0.311234		0.747297
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.971990		0.974690
(t Stat.)	39.164212		40.831025
(P Value)	0.000000		0.000000
R^2	0.928564		0.933900
Significance-F	0.000000		0.000000
Composite-Value			
α_i-Alpha	0.011871		0.008614
(t Stat.)	1.813725		1.365074
(P Value)	0.072261	*	0.174827
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.948850		0.953858
(t Stat.)	27.649725		28.821949
(P Value)	0.000000		0.000000
R^2	0.866290		0.875620
Significance-F	0.000000		0.000000
Composite-Small Size			
α_i-Alpha	0.016185		0.013177

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
(t Stat.)	1.593259		1.294882
(P Value)	0.113777		0.197889
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.871513		0.870593
(t Stat.)	16.362927		16.311536
(P Value)	0.000000		0.000000
R^2	0.694099		0.692761
Significance-F	0.000000		0.000000
Composite-Low Volatility			
α_i-Alpha	0.006382		0.003580
(t Stat.)	0.847497		0.519232
(P Value)	0.398434		0.604571
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.827350		0.844975
(t Stat.)	20.953881		23.364641
(P Value)	0.000000		0.000000
R^2	0.788176		0.822264
Significance-F	0.000000		0.000000
Composite-High Yield			
α_i-Alpha	0.019177		0.016100
(t Stat.)	1.692042		1.468630
(P Value)	0.093277	*	0.144594
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.904406		0.918854
(t Stat.)	15.220147		15.981214
(P Value)	0.000000		0.000000
R^2	0.662522		0.683984
Significance-F	0.000000		0.000000
Composite-Quality			
α_i-Alpha	0.004284		0.001200
(t Stat.)	0.575397		0.170210
(P Value)	0.566118		0.865137
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.902699		0.912763
(t Stat.)	23.125499		24.684179
(P Value)	0.000000		0.000000
R^2	0.819237		0.837758
Significance-F	0.000000		0.000000
Composite-Momentum			

Table 25. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2002)

	BIST-100 June 1993-June 2002		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2002
α_i-Alpha	0.004814		0.001470
(t Stat.)	1.016999		0.322960
(P Value)	0.311234		0.747297
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.971990		0.974690
(t Stat.)	39.164212		40.831025
(P Value)	0.000000		0.000000
R^2	0.928564		0.933900
Significance-F	0.000000		0.000000
Composite-All Factors			
α_i-Alpha	0.010452		0.007357
(t Stat.)	1.683725		1.263674
(P Value)	0.094878	*	0.208838
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.904468		0.912622
(t Stat.)	27.789030		29.888742
(P Value)	0.000000		0.000000
R^2	0.867450		0.883323
Significance-F	0.000000		0.000000

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019
Book to Price-Value			
α_i-Alpha	0.006439		0.004878
(t Stat.)	2.049069		1.592125
(P Value)	0.041748	**	0.112920
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.705789		0.738517
(t Stat.)	18.827620		19.616262
(P Value)	0.000000		0.000000
R^2	0.637004		0.655759
Significance-F	0.000000		0.000000
Net Earnings to Price-Value			

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019
α_i-Alpha	0.007575		0.005747
(t Stat.)	1.854979		1.430093
(P Value)	0.065056	*	0.154235
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.832309		0.868427
(t Stat.)	17.083050		17.585833
(P Value)	0.000000		0.000000
R^2	0.590953		0.604899
Significance-F	0.000000		0.000000
EBIT-DA-Value			
α_i-Alpha	0.003765		0.001759
(t Stat.)	2.288909		1.122995
(P Value)	0.023119	**	0.262772
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.928742		0.961918
(t Stat.)	47.324225		49.967826
(P Value)	0.000000		0.000000
R^2	0.917267		0.925151
Significance-F	0.000000		0.000000
Total MCAP-Small Size			
α_i-Alpha	0.003837		0.002303
(t Stat.)	1.041532		0.643325
(P Value)	0.298874		0.520743
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.678800		0.716933
(t Stat.)	15.445258		16.294664
(P Value)	0.000000		0.000000
R^2	0.541488		0.567929
Significance-F	0.000000		0.000000
Free Float MCAP-Small Size			
α_i-Alpha	0.004896		0.003370
(t Stat.)	1.335661		0.941657
(P Value)	0.183163		0.347493
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.681370		0.716891
(t Stat.)	15.580669		16.300194
(P Value)	0.000000		0.000000
R^2	0.545820		0.568096
Significance-F	0.000000		0.000000

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Standard Deviation-Low Volatility				
α_i-Alpha	0.006748		0.005000	
(t Stat.)	2.752186		2.185740	
(P Value)	0.006459	***	0.029984	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.783570		0.822911	
(t Stat.)	26.788042		29.271084	
(P Value)	0.000000		0.000000	
R^2	0.780339		0.809217	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.003869		0.002499	
(t Stat.)	1.287417		0.853607	
(P Value)	0.199422		0.394334	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.614609		0.645368	
(t Stat.)	17.140859		17.937673	
(P Value)	0.000000		0.000000	
R^2	0.592585		0.614327	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.011378		0.009578	
(t Stat.)	2.488146		2.125219	
(P Value)	0.013650	**	0.034783	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.815100		0.852310	
(t Stat.)	14.941124		15.389280	
(P Value)	0.000000		0.000000	
R^2	0.524971		0.539685	
Significance-F	0.000000		0.000000	
ROE-Quality				
α_i-Alpha	0.010212		0.008375	
(t Stat.)	1.624343		1.339522	
(P Value)	0.105862		0.181906	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.837984		0.873474	
(t Stat.)	11.172112		11.367802	
(P Value)	0.000000		0.000000	
R^2	0.381915		0.390146	
Significance-F	0.000000		0.000000	

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Trailing Five-Year Average Earnings Growth-Quality				
α_i-Alpha	-0.001425		-0.003115	
(t Stat.)	-0.314637		-0.697929	
(P Value)	0.753362		0.486024	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.762100		0.798342	
(t Stat.)	14.104258		14.556161	
(P Value)	0.000000		0.000000	
R^2	0.496172		0.511938	
Significance-F	0.000000		0.000000	
Financial Leverage-Quality				
α_i-Alpha	0.003032		0.001038	
(t Stat.)	1.030425		0.365386	
(P Value)	0.304043		0.715206	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.910093		0.948517	
(t Stat.)	25.924808		27.179779	
(P Value)	0.000000		0.000000	
R^2	0.768904		0.785276	
Significance-F	0.000000		0.000000	
Momentum-Momentum				
α_i-Alpha	0.000354		-0.001390	
(t Stat.)	0.201185		-0.816122	
(P Value)	0.840756		0.415392	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.806967		0.835953	
(t Stat.)	38.439353		39.946487	
(P Value)	0.000000		0.000000	
R^2	0.879732		0.887636	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.005926		0.004128	
(t Stat.)	2.562422		1.864808	
(P Value)	0.011123	**	0.063659	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.822280		0.856287	
(t Stat.)	29.800935		31.478680	
(P Value)	0.000000		0.000000	
R^2	0.814695		0.830666	
Significance-F	0.000000		0.000000	

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Composite-Small Size				
α_i-Alpha	0.004366		0.002837	
(t Stat.)	1.221219		0.815761	
(P Value)	0.223427		0.415598	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.680085		0.716912	
(t Stat.)	15.943443		16.776598	
(P Value)	0.000000		0.000000	
R^2	0.557205		0.582174	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.005309		0.003750	
(t Stat.)	2.217183		1.657453	
(P Value)	0.027726	**	0.098980	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.699089		0.734139	
(t Stat.)	24.474045		26.406281	
(P Value)	0.000000		0.000000	
R^2	0.747809		0.775379	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.011378		0.009578	
(t Stat.)	2.488146		2.125219	
(P Value)	0.013650	**	0.034783	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.815100		0.852310	
(t Stat.)	14.941124		15.389280	
(P Value)	0.000000		0.000000	
R^2	0.524971		0.539685	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.003940		0.002099	
(t Stat.)	1.202653		0.658705	
(P Value)	0.230518		0.510835	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.836726		0.873444	
(t Stat.)	21.409079		22.300535	
(P Value)	0.000000		0.000000	
R^2	0.694101		0.711145	

Table 26. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 2003-June 2019)

	BIST-100 June 2003-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 2003-June 2019	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.000354		-0.001390	
(t Stat.)	0.201185		-0.816122	
(P Value)	0.840756		0.415392	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.806967		0.835953	
(t Stat.)	38.439353		39.946487	
(P Value)	0.000000		0.000000	
R^2	0.879732		0.887636	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.005212		0.003500	
(t Stat.)	2.393389		1.708101	
(P Value)	0.017609	**	0.089154	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.776708		0.811508	
(t Stat.)	29.895392		32.224646	
(P Value)	0.000000		0.000000	
R^2	0.815649		0.837153	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Book to Price-Value				
α_i-Alpha	0.010931		0.008652	
(t Stat.)	2.631051		2.101754	
(P Value)	0.008922	***	0.036351	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.893845		0.903838	
(t Stat.)	28.780617		29.155645	
(P Value)	0.000000		0.000000	
R^2	0.720079		0.725268	
Significance-F	0.000000		0.000000	

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Net Earnings to Price-Value				
α_i-Alpha	0.009499		0.007155	
(t Stat.)	2.172505		1.698222	
(P Value)	0.030547	**	0.090432	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.911244		0.931661	
(t Stat.)	27.879294		29.361997	
(P Value)	0.000000		0.000000	
R^2	0.707074		0.728070	
Significance-F	0.000000		0.000000	
EBIT-DA-Value				
α_i-Alpha	0.003216		0.000806	
(t Stat.)	1.732236		0.455215	
(P Value)	0.084189	*	0.649261	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.945442		0.955571	
(t Stat.)	68.115799		71.645176	
(P Value)	0.000000		0.000000	
R^2	0.935104		0.940972	
Significance-F	0.000000		0.000000	
Total MCAP-Small Size				
α_i-Alpha	0.007865		0.005769	
(t Stat.)	1.741906		1.291639	
(P Value)	0.082480	*	0.197409	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.820095		0.831102	
(t Stat.)	24.299675		24.707098	
(P Value)	0.000000		0.000000	
R^2	0.647113		0.654670	
Significance-F	0.000000		0.000000	
Free Float MCAP-Small Size				
α_i-Alpha	0.008879		0.006773	
(t Stat.)	1.963219		1.509844	
(P Value)	0.050481	*	0.132064	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.825438		0.835380	
(t Stat.)	24.415295		24.729238	
(P Value)	0.000000		0.000000	
R^2	0.649278		0.655075	
Significance-F	0.000000		0.000000	

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Standard Deviation-Low Volatility				
α_i-Alpha	0.005232		0.003113	
(t Stat.)	1.335283		0.843104	
(P Value)	0.182727		0.399796	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.818522		0.843550	
(t Stat.)	27.945156		30.334280	
(P Value)	0.000000		0.000000	
R^2	0.708051		0.740776	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.005683		0.003687	
(t Stat.)	1.487806		1.013467	
(P Value)	0.137781		0.311598	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.772500		0.794086	
(t Stat.)	27.055104		28.981983	
(P Value)	0.000000		0.000000	
R^2	0.694491		0.722881	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.014093		0.011823	
(t Stat.)	2.774954		2.394267	
(P Value)	0.005843	***	0.017225	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.881390		0.902471	
(t Stat.)	23.217814		24.269309	
(P Value)	0.000000		0.000000	
R^2	0.626045		0.646542	
Significance-F	0.000000		0.000000	
ROE-Quality				
α_i-Alpha	0.008207		0.006050	
(t Stat.)	1.598704		1.214247	
(P Value)	0.110867		0.225543	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.835237		0.857999	
(t Stat.)	21.766997		22.866587	
(P Value)	0.000000		0.000000	
R^2	0.595377		0.618881	
Significance-F	0.000000		0.000000	

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Trailing Five-Year Average Earnings Growth-Quality				
α_i-Alpha	-0.004821		-0.006857	
(t Stat.)	-0.842345		-1.189390	
(P Value)	0.400220		0.235163	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.805061		0.805719	
(t Stat.)	18.818556		18.557101	
(P Value)	0.000000		0.000000	
R^2	0.523766		0.516782	
Significance-F	0.000000		0.000000	
Financial Leverage-Quality				
α_i-Alpha	0.008432		0.005801	
(t Stat.)	1.922686		1.410859	
(P Value)	0.055401	*	0.159252	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.018742		1.046991	
(t Stat.)	31.075478		33.814588	
(P Value)	0.000000		0.000000	
R^2	0.749939		0.780269	
Significance-F	0.000000		0.000000	
Momentum-Momentum				
α_i-Alpha	0.001686		-0.000689	
(t Stat.)	0.789802		-0.338080	
(P Value)	0.430225		0.735523	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.930655		0.941634	
(t Stat.)	58.330126		61.374003	
(P Value)	0.000000		0.000000	
R^2	0.913543		0.921248	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.007882		0.005538	
(t Stat.)	2.767888		2.029823	
(P Value)	0.005969	***	0.043196	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.916844		0.930357	
(t Stat.)	43.069307		45.282595	
(P Value)	0.000000		0.000000	
R^2	0.852088		0.864279	

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
Significance-F	0.000000		0.000000	
Composite-Small Size				
α_i-Alpha	0.008372		0.006271	
(t Stat.)	1.895093		1.433706	
(P Value)	0.058976	*	0.152627	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.822767		0.833241	
(t Stat.)	24.915421		25.295718	
(P Value)	0.000000		0.000000	
R^2	0.658456		0.665237	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.005458		0.003400	
(t Stat.)	1.715457		1.160243	
(P Value)	0.087223	*	0.246810	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.795511		0.818818	
(t Stat.)	33.450987		37.100504	
(P Value)	0.000000		0.000000	
R^2	0.776539		0.810415	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.014093		0.011823	
(t Stat.)	2.774954		2.394267	
(P Value)	0.005843	***	0.017225	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.881390		0.902471	
(t Stat.)	23.217814		24.269309	
(P Value)	0.000000		0.000000	
R^2	0.626045		0.646542	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.003939		0.001664	
(t Stat.)	1.147086		0.507395	
(P Value)	0.252198		0.612225	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.886347		0.903570	
(t Stat.)	34.527179		36.576307	
(P Value)	0.000000		0.000000	

Table 27. Monthly Jensen's Alpha-(αi) of Factor Investing Risk Factor Portfolios - 30th Percentile Breakpoint-(June 1993-June 2019)

	BIST-100 June 1993-June 2019		Total Return Index (XUTUM_CFNNTLTL) June 1993-June 2019	
R^2	0.787336		0.806004	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.001686		-0.000689	
(t Stat.)	0.789802		-0.338080	
(P Value)	0.430225		0.735523	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.930655		0.941634	
(t Stat.)	58.330126		61.374003	
(P Value)	0.000000		0.000000	
R^2	0.913543		0.921248	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.006905		0.004668	
(t Stat.)	2.558308		1.850008	
(P Value)	0.010976	**	0.065228	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.872252		0.888348	
(t Stat.)	43.233552		46.751602	
(P Value)	0.000000		0.000000	
R^2	0.853045		0.871596	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

5.9 Fama-French three-factor analysis for testing Jensen's alpha

As a further refinement to our empirical analysis, we include Fama and French's (1993) Size and BE/ME-(Book Equity/Market Equity) factors as additional explanatory variables in the regression equations. A Fama-French style calculation methodology was employed to form zero-cost portfolios in the case of Size and BE/ME risk factors. Size risk factor incorporates total MCAP rather than free-float MCAP. Banks and financial institutions' stocks are included in the calculations as a

diversion from the Fama-French methodology. Fama-French excluded financial firms from their study as high leverage, a typical characteristic of a bank balance sheet, may mean distress in a non-financial firm's financial statement. We tend to include financial stocks in our coverage as not doing so may lead to misrepresentations due to financial stocks' sizeable share in Turkish stock market's total market capitalization.

By introducing Fama-French risk factors into the regression equations, we aim to test whether the inclusion of Size and BE/ME factors as additional explanatory variables in the regression equation will improve the statistical significance of the functional form and bring in a meaningful reduction in Jensen's alpha. We limit our work to June 2003-June 2019 sub-period in order to leave out the anomalous effects of macroeconomic adversities on Turkish financial markets during the June 1993-June 2002 sub-period.

5.9.1 Fama-French three-factor analysis for testing Jensen's alpha-fundamental indexation

Table 28 shows the Jensen's alpha of each factor in AHM-Fundamental Indexation for the June 2003-June 2019 period with and without SMB-(Small minus Big) and HML-(High minus Low) Portfolios. The findings suggest that the inclusion of the SMB-(Small minus Big) and HML-(High minus Low) Portfolios as the second and third explanatory variables in the regression equations does not improve the statistical significance and R^2. It also does not induce a sizeable reduction in Jensen's alpha in any AHM-Fundamental Indexation risk factors.

Table 28. Monthly Jensen's Alpha-(α_i) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor		(June 2003-June 2019)-without Three Factor	
Book Value				
α_i-Alpha	0.001318		0.001842	
(t Stat.)	1.464966		2.085966	
(P Value)	0.144501		0.038237	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.032574		1.037959	
(t Stat.)	88.624833		95.626338	
(P Value)	0.000000		0.000000	
SMB	-0.004700			
(t Stat.)	-0.227497			
(P Value)	0.820270			
HML	0.054970			
(t Stat.)	2.382802			
(P Value)	0.018118			
R^2	0.979044		0.978387	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Net Sales				
α_i-Alpha	0.002782		0.003062	
(t Stat.)	2.208314		2.465763	
(P Value)	0.028358	**	0.014506	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.004872		0.991265	
(t Stat.)	61.566806		64.954793	
(P Value)	0.000000		0.000000	
SMB	0.077469			
(t Stat.)	2.676781			
(P Value)	0.008050			
HML	0.043440			
(t Stat.)	1.344188			
(P Value)	0.180410			
R^2	0.956019		0.954310	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Gross Dividends				
α_i-Alpha	0.004041		0.004640	
(t Stat.)	1.311706		1.554886	
(P Value)	0.191123		0.121539	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.008260		1.011658	
(t Stat.)	25.263374		27.585061	

Table 28. Monthly Jensen's Alpha-(α_i) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor		(June 2003-June 2019)-without Three Factor	
(P Value)	0.000000		0.000000	
SMB	0.007973			
(t Stat.)	0.112668			
(P Value)	0.910407			
HML	0.065095			
(t Stat.)	0.823760			
(P Value)	0.411057			
R^2	0.790939		0.790225	
Significance-F	0.000000		0.000000	
Trailing Five-year Average Cash Flow				
α_i-Alpha	0.002306		0.002920	
(t Stat.)	1.634225		2.056945	
(P Value)	0.103785		0.040976	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.950096		0.930434	
(t Stat.)	51.982845		53.343226	
(P Value)	0.000000		0.000000	
SMB	0.120508			
(t Stat.)	3.718437			
(P Value)	0.000260			
HML	0.086586			
(t Stat.)	2.392617			
(P Value)	0.017654			
R^2	0.938753		0.933716	
Significance-F	0.000000		0.000000	
Composite-AHM				
α_i-Alpha	0.002612		0.003116	
(t Stat.)	2.102223		2.557444	
(P Value)	0.036785	**	0.011278	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.998951		0.992829	
(t Stat.)	62.070641		66.306611	
(P Value)	0.000000		0.000000	
SMB	0.050313			
(t Stat.)	1.763070			
(P Value)	0.079416			
HML	0.062523			
(t Stat.)	1.962062			

Table 28. Monthly Jensen's Alpha-(α_i) of Fundamental Indexation-AHM Methodology Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor
(P Value)	0.051143	
R^2	0.957294	0.956073
Significance-F	0.000000	0.000000

Note: ***p<0.01, **p<0.05, *p<0.10.

5.9.2 Fama-French three-factor analysis for testing Jensen's alpha-factor investing

Table 29 shows the Jensen's alpha of each factor in factor investing risk factors for the June 2003-June 2019 period with and without SMB-(Small minus Big) and HML-(High minus Low) Portfolios. We limit our analysis to the median breakpoint portfolios due to their better statistical significance and more significant alpha potential than the 30th percentile breakpoint portfolios. The findings suggest that the inclusion of the SMB-(Small minus Big) and HML-(High minus Low) portfolios as the second and third explanatory variables in the regression equations seems to have little effect on the statistical significance and R^2 in the majority of risk factors. The only exception is "Standard Deviation." Including Fama-French risk factors in its regression equation seems to reduce Jensen's alpha and bring in a mild improvement in R^2 while staying at a 95% confidence level. Other risk factors seem to demonstrate no substantial improvement.

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor	
Book to Price-Value			
α_i-Alpha	0.002540	0.005368	
(t Stat.)	1.225880	1.934895	
(P Value)	0.221685	0.054400	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.863716	0.764173	
(t Stat.)	32.182291	22.414354	
(P Value)	0.000000	0.000000	
SMB	0.598696		
(t Stat.)	12.580643		
(P Value)	0.000000		
HML	0.406685		
(t Stat.)	7.653059		
(P Value)	0.000000		
R^2	0.850451	0.713232	
Significance-F	0.000000	0.000000	
Net Earnings to Price-Value			
α_i-Alpha	0.004050	0.006262	
(t Stat.)	1.262146	1.797585	
(P Value)	0.208366	0.073736	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.918187	0.834124	
(t Stat.)	22.088109	19.485885	
(P Value)	0.000000	0.000000	
SMB	0.498359		
(t Stat.)	6.761151		
(P Value)	0.000000		
HML	0.323338		
(t Stat.)	3.928400		
(P Value)	0.000118		
R^2	0.724417	0.652742	
Significance-F	0.000000	0.000000	
EBIT-DA-Value			
α_i-Alpha	0.001737	0.002199	
(t Stat.)	1.197560	1.558139	
(P Value)	0.232506	0.120766	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.957984	0.954954	
(t Stat.)	51.000357	55.049758	
(P Value)	0.000000	0.000000	
SMB	0.033614		

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor
(t Stat.)	1.009209	
(P Value)	0.314094	
HML	0.055171	
(t Stat.)	1.483405	
(P Value)	0.139541	
R^2	0.938339	0.937509
Significance-F	0.000000	0.000000
Total MCAP-Small Size		
α_i-Alpha	0.000052	0.000863
(t Stat.)	0.040578	0.291860
(P Value)	0.967673	0.770693
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.948724	0.769922
(t Stat.)	56.976988	21.187620
(P Value)	0.000000	0.000000
SMB	0.900995	
(t Stat.)	30.516351	
(P Value)	0.000000	
HML	0.245703	
(t Stat.)	7.452489	
(P Value)	0.000000	
R^2	0.945165	0.689668
Significance-F	0.000000	0.000000
Free Float MCAP-Small Size		
α_i-Alpha	0.002108	0.002668
(t Stat.)	1.320840	0.865298
(P Value)	0.188064	0.387902
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.937119	0.757131
(t Stat.)	45.332055	19.985473
(P Value)	0.000000	0.000000
SMB	0.896491	
(t Stat.)	24.457234	
(P Value)	0.000000	
HML	0.218191	
(t Stat.)	5.330636	
(P Value)	0.000000	
R^2	0.915838	0.664128
Significance-F	0.000000	0.000000

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor		(June 2003-June 2019)-without Three Factor	
Standard Deviation-Low Volatility				
α_i-Alpha	0.003596		0.004875	
(t Stat.)	2.045632		2.077828	
(P Value)	0.042102	**	0.038989	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.940253		0.840690	
(t Stat.)	41.289558		29.154810	
(P Value)	0.000000		0.000000	
SMB	0.535520			
(t Stat.)	13.262390			
(P Value)	0.000000			
HML	0.230824			
(t Stat.)	5.119274			
(P Value)	0.000001			
R^2	0.899222		0.807985	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.001897		0.001312	
(t Stat.)	0.827290		0.542195	
(P Value)	0.409059		0.588282	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.763872		0.693797	
(t Stat.)	25.711135		23.328543	
(P Value)	0.000000		0.000000	
SMB	0.316223			
(t Stat.)	6.002677			
(P Value)	0.000000			
HML	-0.006259			
(t Stat.)	-0.106396			
(P Value)	0.112047			
R^2	0.772663		0.729303	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.007163		0.009415	
(t Stat.)	1.853222		2.380291	
(P Value)	0.065324	*	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.909697		0.848663	
(t Stat.)	18.169564		17.460144	
(P Value)	0.000000		0.000000	

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor
SMB	0.388230	
(t Stat.)	4.373080	
(P Value)	0.000020	
HML	0.308148	
(t Stat.)	3.108410	
(P Value)	0.002155	
R^2	0.644147	0.601465
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.006531	0.008305
(t Stat.)	1.148208	1.442412
(P Value)	0.252254	0.150735
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.969768	0.870485
(t Stat.)	13.160987	12.302892
(P Value)	0.000000	0.000000
SMB	0.554343	
(t Stat.)	4.242773	
(P Value)	0.000034	
HML	0.286685	
(t Stat.)	1.964976	
(P Value)	0.050802	
R^2	0.478254	0.428347
Significance-F	0.000000	0.000000
Trailing Five-Year Average Earnings Growth-Quality		
α_i-Alpha	-0.004844	-0.002675
(t Stat.)	-1.190240	-0.616116
(P Value)	0.235363	0.538512
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.907602	0.804227
(t Stat.)	17.216092	15.074105
(P Value)	0.000000	0.000000
SMB	0.590375	
(t Stat.)	6.315643	
(P Value)	0.000000	
HML	0.335150	
(t Stat.)	3.210780	
(P Value)	0.001542	
R^2	0.613307	0.529388

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor	
Significance-F	0.000000	0.000000	
Financial Leverage-Quality			
α_i-Alpha	-0.000118	0.000696	
(t Stat.)	-0.041859	0.243909	
(P Value)	0.966653	0.807549	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.998403	0.950415	
(t Stat.)	27.257400	27.108208	
(P Value)	0.000000	0.000000	
SMB	0.266185		
(t Stat.)	4.098391		
(P Value)	0.000060		
HML	0.133694		
(t Stat.)	1.843415		
(P Value)	0.066748		
R^2	0.801951	0.784385	
Significance-F	0.000000	0.000000	
Momentum-Momentum			
α_i-Alpha	0.001685	0.000363	
(t Stat.)	1.535185	0.322047	
(P Value)	0.126319	0.747750	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.938541	0.929264	
(t Stat.)	66.010867	67.012364	
(P Value)	0.000000	0.000000	
SMB	-0.008964		
(t Stat.)	-0.355550		
(P Value)	0.722552		
HML	-0.142116		
(t Stat.)	-5.048193		
(P Value)	0.000001		
R^2	0.961918	0.956954	
Significance-F	0.000000	0.000000	
Composite-Value			
α_i-Alpha	0.002776	0.004610	
(t Stat.)	1.634134	2.257032	
(P Value)	0.103804	0.025076	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.913296	0.851084	
(t Stat.)	41.510002	33.909797	

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor	(June 2003-June 2019)-without Three Factor
(P Value)	0.000000	0.000000
SMB	0.376890	
(t Stat.)	9.660648	
(P Value)	0.000000	
HML	0.261731	
(t Stat.)	6.007982	
(P Value)	0.000000	
R^2	0.903370	0.850578
Significance-F	0.000000	0.000000
Composite-Small Size		
α_i-Alpha	0.001080	0.001765
(t Stat.)	0.813346	0.594809
(P Value)	0.416987	0.552637
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.942922	0.763526
(t Stat.)	54.818303	20.935084
(P Value)	0.000000	0.000000
SMB	0.898743	
(t Stat.)	29.467022	
(P Value)	0.000000	
HML	0.231947	
(t Stat.)	6.810362	
(P Value)	0.000000	
R^2	0.940945	0.684512
Significance-F	0.000000	0.000000
Composite-Low Volatility		
α_i-Alpha	0.002747	0.001019
(t Stat.)	1.557557	0.687017
(P Value)	0.120919	0.492860
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.852063	0.830638
(t Stat.)	37.298951	45.551965
(P Value)	0.000000	0.000000
SMB	0.425872	
(t Stat.)	10.513672	
(P Value)	0.000000	
HML	0.112283	
(t Stat.)	2.482386	
(P Value)	0.013874	
R^2	0.877879	0.911286

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor		(June 2003-June 2019)-without Three Factor	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.007163		0.009415	
(t Stat.)	1.853222		2.380291	
(P Value)	0.065324	*	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.909697		0.848663	
(t Stat.)	18.169564		17.460144	
(P Value)	0.000000		0.000000	
SMB	0.388230			
(t Stat.)	4.373080			
(P Value)	0.000020			
HML	0.308148			
(t Stat.)	3.108410			
(P Value)	0.002155			
R^2	0.644147		0.601465	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.000523		0.002109	
(t Stat.)	0.188273		0.690843	
(P Value)	0.850853		0.490457	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.958591		0.875042	
(t Stat.)	26.638520		23.329065	
(P Value)	0.000000		0.000000	
SMB	0.470301			
(t Stat.)	7.370609			
(P Value)	0.000000			
HML	0.251843			
(t Stat.)	3.534587			
(P Value)	0.000507			
R^2	0.790334		0.729312	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.001685		0.000363	
(t Stat.)	1.535185		0.322047	
(P Value)	0.126319		0.747750	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.938541		0.929264	
(t Stat.)	66.010867		67.012364	

Table 29. Monthly Jensen's Alpha-(α_i) of Median Breakpoint Factor Investing Risk Factor Portfolios-(Inclusion of Fama-French Size and BE/ME Portfolios)

Market Proxy-Total Return Index-(XUTUM_CFNNTLTL)

	(June 2003-June 2019)-with Three Factor		(June 2003-June 2019)-without Three Factor	
(P Value)	0.000000		0.000000	
SMB	-0.008964			
(t Stat.)	-0.355550			
(P Value)	0.722552			
HML	-0.142116			
(t Stat.)	-5.048193			
(P Value)	0.000001			
R^2	0.961918		0.956954	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.002662		0.003213	
(t Stat.)	1.835540		1.835492	
(P Value)	0.067911	*	0.067903	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.919185		0.849703	
(t Stat.)	48.924958		39.493570	
(P Value)	0.000000		0.000000	
SMB	0.425179			
(t Stat.)	12.762911			
(P Value)	0.000000			
HML	0.170639			
(t Stat.)	4.587103			
(P Value)	0.000008			
R^2	0.926290		0.885341	
Significance-F	0.000000		0.000000	

Note: ***p<0.01, **p<0.05,
*p<0.10.

5.10 Jensen's alpha for 130/30 long-short alternative strategy portfolios

We construct 130/30 long-short portfolios for factor investing risk factors and test whether we can enhance Jensen's alphas' statistical significance and magnitude for some underperforming factors. The exercise is limited to median breakpoint portfolios due to their better statistical significance and more significant alpha potential than 30th percentile breakpoint portfolios. In this investment strategy, the

numbers “130” and “30” indicate a 130% weighting in long positions and a 30% in short positions within the same portfolio. The 130/30 portfolios are designed to have a beta of one. Hence, the 130/30 portfolio is structured such that the targeted net portfolio beta is the same beta value as that of the market (beta of risk factor in our case). As the newly constructed 130/30 portfolio will have the same systematic risk as to the market, it is expected that this strategy will deliver positive alpha without incurring additional market risk. It is a well-known and frequently executed strategy among asset management practitioners to enhance return with limited or no additional risk.

Table 30, Table 31 and Table 32 show the 130/30 median breakpoint factor investing portfolios' alpha generation potential and the model's strength in terms of statistical significance in comparison to median breakpoint long-only factor investing portfolios. In terms of statistical significance, the June 1993-June 2002 sub-period turns out to be disappointing. There is no statistically significant alpha for factor investing portfolios within the 95% confidence interval. There is an improvement in p values and alpha generation, but 130/30 portfolios come short of becoming statistically significant at a 95% confidence level in this volatile sub-period. In the entire analysis period of June 1993-June 2019, we see a substantial improvement in the statistical significance and the magnitude of alpha, especially in the already best performing risk factors of “Book to Price” and “Gross Dividend Yield.” However, there is also an improvement in "Earnings to Price," just shy of a 95% confidence interval. The sub-period of June 2003-June 2019 proved to be a dismal performance for long-only portfolios. With the help of the 130/30 strategy, the "Book to Price" risk factor's alpha became statistically significant at a 95% confidence level and enhanced considerably in its magnitude. The best performance comes with the

"Standard Deviation" risk factor's alpha. It not only improved in terms of its statistical significance but grew sizeably in magnitude as well. The best performing long-only "Gross Dividend Yield" risk factor's alpha was also significantly enhanced with a slight loss in its statistical significance. The "Composite-All Factors" risk factor alpha also became statistically significant at a 95% confidence level while showing an increase in magnitude. It is worth noting that, under the 130/30 investment scheme, we observe a loss in R^2 in all good performing factors' regression equations.

The factors that performed well in zero-cost portfolio returns were expected to improve under the 130/30 scheme. We also expected to see some borderline performances of positive alpha factors that were very close to becoming statistically significant to improve and become statistically significant under the 130/30 scheme. As expected, the 130/30 strategy has paid off quite effectively in the already good performing risk factors (statistically significant alpha generation with a long-only strategy and sizeable the zero-cost portfolio returns) and some borderline performers. 130/30 alternative investment strategy had a profound effect, especially on already good performers, as leverage helps multiply the existing relationship.

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30 June 1993-June 2002	Long-only June 1993-June 2002
Book to Price-Value		
α_i-Alpha	0.022532	0.017725
(t Stat.)	1.970641	1.865747
(P Value)	0.051106 *	0.064560 *

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2002	June 1993-June 2002
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.973070	0.958310
(t Stat.)	16.226526	19.232911
(P Value)	0.000000	0.000000
R^2	0.690533	0.758150
Significance-F	0.000000	0.000000
Net Earnings to Price-Value		
α_i-Alpha	0.010728	0.008473
(t Stat.)	1.187009	1.092694
(P Value)	0.237608	0.276754
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.961233	0.943010
(t Stat.)	20.278969	23.188151
(P Value)	0.000000	0.000000
R^2	0.777037	0.820037
Significance-F	0.000000	0.000000
EBIT-DA-Value		
α_i-Alpha	-0.004566	-0.001033
(t Stat.)	-0.967668	-0.253508
(P Value)	0.335189	0.800316
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.955377	0.945155
(t Stat.)	38.604616	44.240113
(P Value)	0.000000	0.000000
R^2	0.926631	0.943138
Significance-F	0.000000	0.000000
Total MCAP-Small Size		
α_i-Alpha	0.009614	0.008827
(t Stat.)	0.713716	0.853455
(P Value)	0.476812	0.395136
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.846801	0.884025
(t Stat.)	11.985859	16.295823
(P Value)	0.000000	0.000000
R^2	0.549035	0.692351
Significance-F	0.000000	0.000000
Free Float MCAP-Small Size		
α_i-Alpha	0.007987	0.007098
(t Stat.)	0.713502	0.813666

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2002	June 1993-June 2002
(P Value)	0.476944	0.417475
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.867541	0.899240
(t Stat.)	14.776013	19.654039
(P Value)	0.000000	0.000000
R^2	0.649155	0.766004
Significance-F	0.000000	0.000000
Standard Deviation-Low Volatility		
α_i-Alpha	-0.003773	0.001435
(t Stat.)	-0.468377	0.211344
(P Value)	0.640379	0.832984
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.852260	0.887794
(t Stat.)	20.171426	24.923131
(P Value)	0.000000	0.000000
R^2	0.775189	0.840360
Significance-F	0.000000	0.000000
Beta-Low Volatility		
α_i-Alpha	0.004154	0.005311
(t Stat.)	0.544230	0.941912
(P Value)	0.587310	0.348162
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.832522	0.881756
(t Stat.)	20.796264	29.814536
(P Value)	0.000000	0.000000
R^2	0.785643	0.882809
Significance-F	0.000000	0.000000
Gross Dividend Yield-High Yield		
α_i-Alpha	0.018711	0.014546
(t Stat.)	1.643736	1.551754
(P Value)	0.102893	0.123399
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.947568	0.926135
(t Stat.)	15.871413	18.837414
(P Value)	0.000000	0.000000
R^2	0.680996	0.750448
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.000741	0.002172

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2002	June 1993-June 2002
(t Stat.)	0.092455	0.322654
(P Value)	0.926494	0.747528
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.858306	0.875315
(t Stat.)	20.414533	24.786812
(P Value)	0.000000	0.000000
R^2	0.779337	0.838883
Significance-F	0.000000	0.000000
Trailing Five-Year Average Earnings Growth-Quality		
α_i-Alpha	-0.016158	-0.013445
(t Stat.)	-1.000916	-1.002299
(P Value)	0.318916	0.318250
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.789207	0.804678
(t Stat.)	9.320857	11.436924
(P Value)	0.000000	0.000000
R^2	0.424049	0.525730
Significance-F	0.000000	0.000000
Financial Leverage-Quality		
α_i-Alpha	0.016145	0.014803
(t Stat.)	1.252676	1.488987
(P Value)	0.212800	0.139159
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.131578	1.079281
(t Stat.)	16.739689	20.697881
(P Value)	0.000000	0.000000
R^2	0.703679	0.784042
Significance-F	0.000000	0.000000
Momentum-Momentum		
α_i-Alpha	0.000654	0.002994
(t Stat.)	0.124833	0.907152
(P Value)	0.900869	0.366175
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.986289	0.988094
(t Stat.)	35.873412	57.076559
(P Value)	0.000000	0.000000
R^2	0.916008	0.965045
Significance-F	0.000000	0.000000

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2002	June 1993-June 2002
Composite-Value		
α_i-Alpha	0.009564	0.008388
(t Stat.)	1.429683	1.329453
(P Value)	0.155450	0.186263
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.963227	0.948825
(t Stat.)	27.452071	28.671823
(P Value)	0.000000	0.000000
R^2	0.864619	0.874478
Significance-F	0.000000	0.000000
Composite-Small Size		
α_i-Alpha	0.008801	0.007963
(t Stat.)	0.779003	0.903696
(P Value)	0.437537	0.367998
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.857171	0.891633
(t Stat.)	14.466424	19.293572
(P Value)	0.000000	0.000000
R^2	0.639450	0.759303
Significance-F	0.000000	0.000000
Composite-Low Volatility		
α_i-Alpha	0.000190	0.001888
(t Stat.)	0.027755	0.476195
(P Value)	0.977904	0.634816
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.842391	0.909653
(t Stat.)	23.410651	43.753393
(P Value)	0.000000	0.000000
R^2	0.822838	0.941939
Significance-F	0.000000	0.000000
Composite-High Yield		
α_i-Alpha	0.018711	0.014546
(t Stat.)	1.643736	1.551754
(P Value)	0.102893	0.123399
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.947568	0.926135
(t Stat.)	15.871413	18.837414
(P Value)	0.000000	0.000000
R^2	0.680996	0.750448
Significance-F	0.000000	0.000000

Table 30. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2002)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2002	June 1993-June 2002
Composite-Quality		
α_i-Alpha	0.000243	0.001177
(t Stat.)	0.031979	0.170955
(P Value)	0.974543	0.864552
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.926364	0.919758
(t Stat.)	23.279695	25.474595
(P Value)	0.000000	0.000000
R^2	0.821197	0.846145
Significance-F	0.000000	0.000000
Composite-Momentum		
α_i-Alpha	0.000654	0.002994
(t Stat.)	0.124833	0.907152
(P Value)	0.900869	0.366175
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.986289	0.988094
(t Stat.)	35.873412	57.076559
(P Value)	0.000000	0.000000
R^2	0.916008	0.965045
Significance-F	0.000000	0.000000
Composite-All Factors		
α_i-Alpha	0.006361	0.006159
(t Stat.)	1.041660	1.196139
(P Value)	0.299699	0.234040
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.920502	0.930683
(t Stat.)	28.742359	34.460416
(P Value)	0.000000	0.000000
R^2	0.875016	0.909615
Significance-F	0.000000	0.000000

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 31. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 2003-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 2003-June 2019		June 2003-June 2019	
Book to Price-Value				
α_i-Alpha	0.006280		0.005368	
(t Stat.)	1.997683		1.934895	
(P Value)	0.047093	**	0.054400	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.732943		0.764173	
(t Stat.)	18.973272		22.414354	
(P Value)	0.000000		0.000000	
R^2	0.640560		0.713232	
Significance-F	0.000000		0.000000	
Net Earnings to Price-Value				
α_i-Alpha	0.007359		0.006262	
(t Stat.)	1.756823		1.797585	
(P Value)	0.080463	*	0.073736	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.831929		0.834124	
(t Stat.)	16.162458		19.485885	
(P Value)	0.000000		0.000000	
R^2	0.563927		0.652742	
Significance-F	0.000000		0.000000	
EBIT-DA-Value				
α_i-Alpha	0.001674		0.002199	
(t Stat.)	0.923124		1.558139	
(P Value)	0.357044		0.120766	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.011700		0.954954	
(t Stat.)	45.410032		55.049758	
(P Value)	0.000000		0.000000	
R^2	0.910780		0.937509	
Significance-F	0.000000		0.000000	
Total MCAP-Small Size				
α_i-Alpha	0.001044		0.000863	
(t Stat.)	0.271452		0.291860	
(P Value)	0.786321		0.770693	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.702061		0.769922	
(t Stat.)	14.847138		21.187620	
(P Value)	0.000000		0.000000	
R^2	0.521823		0.689668	
Significance-F	0.000000		0.000000	

Table 31. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 2003-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 2003-June 2019		June 2003-June 2019	
Free Float MCAP-Small Size				
α_i-Alpha	0.003435		0.002668	
(t Stat.)	0.850092		0.865298	
(P Value)	0.396281		0.387902	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.678513		0.757131	
(t Stat.)	13.665152		19.985473	
(P Value)	0.000000		0.000000	
R^2	0.480368		0.664128	
Significance-F	0.000000		0.000000	
Standard Deviation-Low Volatility				
α_i-Alpha	0.006386		0.004875	
(t Stat.)	2.479223		2.077828	
(P Value)	0.013986	**	0.038989	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.851765		0.840690	
(t Stat.)	26.909198		29.154810	
(P Value)	0.000000		0.000000	
R^2	0.781882		0.807985	
Significance-F	0.000000		0.000000	
Beta-Low Volatility				
α_i-Alpha	0.001689		0.001312	
(t Stat.)	0.524304		0.542195	
(P Value)	0.600642		0.588282	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.577936		0.693797	
(t Stat.)	14.602577		23.328543	
(P Value)	0.000000		0.000000	
R^2	0.513529		0.729303	
Significance-F	0.000000		0.000000	
Gross Dividend Yield-High Yield				
α_i-Alpha	0.011458		0.009415	
(t Stat.)	2.322135		2.380291	
(P Value)	0.021222	**	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.853252		0.848663	
(t Stat.)	14.071575		17.460144	
(P Value)	0.000000		0.000000	
R^2	0.495012		0.601465	

Table 31. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 2003-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 2003-June 2019	June 2003-June 2019
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.009227	0.008305
(t Stat.)	1.268979	1.442412
(P Value)	0.205909	0.150735
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.882619	0.870485
(t Stat.)	9.877272	12.302892
(P Value)	0.000000	0.000000
R^2	0.325679	0.428347
Significance-F	0.000000	0.000000
Trailing Five-Year Average Earnings Growth-Quality		
α_i-Alpha	-0.004740	-0.002675
(t Stat.)	-0.877982	-0.616116
(P Value)	0.380996	0.538512
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.792430	0.804227
(t Stat.)	11.945110	15.074105
(P Value)	0.000000	0.000000
R^2	0.413959	0.529388
Significance-F	0.000000	0.000000
Financial Leverage-Quality		
α_i-Alpha	0.000259	0.000696
(t Stat.)	0.074976	0.243909
(P Value)	0.940308	0.807549
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.978366	0.950415
(t Stat.)	23.018967	27.108208
(P Value)	0.000000	0.000000
R^2	0.723996	0.784385
Significance-F	0.000000	0.000000
Momentum-Momentum		
α_i-Alpha	0.000571	0.000363
(t Stat.)	0.339925	0.322047
(P Value)	0.734267	0.747750
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.888737	0.929264
(t Stat.)	43.065149	67.012364

Table 31. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 2003-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 2003-June 2019		June 2003-June 2019	
(P Value)	0.000000		0.000000	
R^2	0.901780		0.956954	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.005104		0.004610	
(t Stat.)	2.358646		2.257032	
(P Value)	0.019296	**	0.025076	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.858857		0.851084	
(t Stat.)	32.297069		33.909797	
(P Value)	0.000000		0.000000	
R^2	0.837764		0.850578	
Significance-F	0.000000		0.000000	
Composite-Small Size				
α_i-Alpha	0.002240		0.001765	
(t Stat.)	0.578226		0.594809	
(P Value)	0.563756		0.552637	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.690287		0.763526	
(t Stat.)	14.502309		20.935084	
(P Value)	0.000000		0.000000	
R^2	0.510086		0.684512	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.004037		0.001019	
(t Stat.)	1.588342		0.687017	
(P Value)	0.113773		0.492860	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.714850		0.830638	
(t Stat.)	22.885601		45.551965	
(P Value)	0.000000		0.000000	
R^2	0.721668		0.911286	
Significance-F	0.000000		0.000000	
Composite-High Yield				
α_i-Alpha	0.011458		0.009415	
(t Stat.)	2.322135		2.380291	
(P Value)	0.021222	**	0.018229	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.853252		0.848663	

Table 31. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 2003-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 2003-June 2019		June 2003-June 2019	
(t Stat.)	14.071575		17.460144	
(P Value)	0.000000		0.000000	
R^2	0.495012		0.601465	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.001582		0.002109	
(t Stat.)	0.439792		0.690843	
(P Value)	0.660558		0.490457	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.884472		0.875042	
(t Stat.)	20.003911		23.329065	
(P Value)	0.000000		0.000000	
R^2	0.664539		0.729312	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.000571		0.000363	
(t Stat.)	0.339925		0.322047	
(P Value)	0.734267		0.747750	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.888737		0.929264	
(t Stat.)	43.065149		67.012364	
(P Value)	0.000000		0.000000	
R^2	0.901780		0.956954	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.004165		0.003213	
(t Stat.)	1.981236		1.835492	
(P Value)	0.048921	**	0.067903	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.815076		0.849703	
(t Stat.)	31.547931		39.493570	
(P Value)	0.000000		0.000000	
R^2	0.831283		0.885341	
Significance-F	0.000000		0.000000	

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 1993-June 2019		June 1993-June 2019	
Book to Price-Value				
α_i-Alpha	0.011681		0.009445	
(t Stat.)	2.467561		2.378256	
(P Value)	0.014123	**	0.017978	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.914698		0.911197	
(t Stat.)	25.657657		30.467028	
(P Value)	0.000000		0.000000	
R^2	0.671534		0.742449	
Significance-F	0.000000		0.000000	
Net Earnings to Price-Value				
α_i-Alpha	0.008273		0.006799	
(t Stat.)	1.940900		1.881596	
(P Value)	0.053143	*	0.060793	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.930352		0.917070	
(t Stat.)	28.984604		33.699497	
(P Value)	0.000000		0.000000	
R^2	0.722917		0.779097	
Significance-F	0.000000		0.000000	
EBIT-DA-Value				
α_i-Alpha	-0.000493		0.001027	
(t Stat.)	-0.235645		0.588581	
(P Value)	0.813858		0.556555	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.969318		0.947800	
(t Stat.)	61.525673		72.124448	
(P Value)	0.000000		0.000000	
R^2	0.921605		0.941708	
Significance-F	0.000000		0.000000	
Total MCAP-Small Size				
α_i-Alpha	0.003846		0.003519	
(t Stat.)	0.693866		0.826308	
(P Value)	0.488266		0.409241	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.811742		0.856263	
(t Stat.)	19.447465		26.695968	
(P Value)	0.000000		0.000000	
R^2	0.540134		0.688791	

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2019	June 1993-June 2019
Significance-F	0.000000	0.000000
Free Float MCAP-Small Size		
α_i-Alpha	0.004633	0.003942
(t Stat.)	0.949547	1.042914
(P Value)	0.343055	0.297771
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.822435	0.865227
(t Stat.)	22.383092	30.397507
(P Value)	0.000000	0.000000
R^2	0.608750	0.741575
Significance-F	0.000000	0.000000
Standard Deviation-Low Volatility		
α_i-Alpha	0.002620	0.003479
(t Stat.)	0.772776	1.196229
(P Value)	0.440222	0.232487
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.853184	0.877023
(t Stat.)	33.417013	40.044916
(P Value)	0.000000	0.000000
R^2	0.776186	0.832779
Significance-F	0.000000	0.000000
Beta-Low Volatility		
α_i-Alpha	0.001944	0.002308
(t Stat.)	0.546826	0.873342
(P Value)	0.584877	0.383128
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.772148	0.836959
(t Stat.)	28.843185	42.052921
(P Value)	0.000000	0.000000
R^2	0.720953	0.845966
Significance-F	0.000000	0.000000
Gross Dividend Yield-High Yield		
α_i-Alpha	0.013902	0.011116
(t Stat.)	2.660666	2.608128
(P Value)	0.008189 ***	0.009528 ***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.924552	0.907314
(t Stat.)	23.497091	28.268852

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-
(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2019	June 1993-June 2019
(P Value)	0.000000	0.000000
R^2	0.631627	0.712789
Significance-F	0.000000	0.000000
ROE-Quality		
α_i-Alpha	0.006145	0.006020
(t Stat.)	1.129641	1.372750
(P Value)	0.259468	0.170786
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.864917	0.874802
(t Stat.)	21.111850	26.489994
(P Value)	0.000000	0.000000
R^2	0.580571	0.685461
Significance-F	0.000000	0.000000
Trailing Five-Year Average Earnings Growth-Quality		
α_i-Alpha	-0.008963	-0.006667
(t Stat.)	-1.308206	-1.179956
(P Value)	0.191737	0.238889
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.791138	0.805675
(t Stat.)	15.333796	18.933856
(P Value)	0.000000	0.000000
R^2	0.422033	0.526812
Significance-F	0.000000	0.000000
Financial Leverage-Quality		
α_i-Alpha	0.005750	0.005591
(t Stat.)	1.092919	1.358488
(P Value)	0.275246	0.175260
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	1.093769	1.047403
(t Stat.)	27.606285	33.796859
(P Value)	0.000000	0.000000
R^2	0.702981	0.780089
Significance-F	0.000000	0.000000
Momentum-Momentum		
α_i-Alpha	0.000350	0.001186
(t Stat.)	0.157374	0.834657

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-
(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 1993-June 2019		June 1993-June 2019	
(P Value)	0.875049		0.404530	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.963243		0.973931	
(t Stat.)	57.585729		90.999736	
(P Value)	0.000000		0.000000	
R^2	0.911493		0.962571	
Significance-F	0.000000		0.000000	
Composite-Value				
α_i-Alpha	0.006487		0.005757	
(t Stat.)	2.287560		2.152830	
(P Value)	0.022811	**	0.032075	**
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.938123		0.925356	
(t Stat.)	43.928953		45.948683	
(P Value)	0.000000		0.000000	
R^2	0.857000		0.867668	
Significance-F	0.000000		0.000000	
Composite-Small Size				
α_i-Alpha	0.004239		0.003731	
(t Stat.)	0.873805		0.990075	
(P Value)	0.382876		0.322881	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.817088		0.860745	
(t Stat.)	22.363494		30.333542	
(P Value)	0.000000		0.000000	
R^2	0.608332		0.740767	
Significance-F	0.000000		0.000000	
Composite-Low Volatility				
α_i-Alpha	0.002282		0.002893	
(t Stat.)	0.756413		1.160954	
(P Value)	0.449955		0.246521	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.812666		0.856991	
(t Stat.)	35.771344		45.659506	
(P Value)	0.000000		0.000000	
R^2	0.798950		0.866212	
Significance-F	0.000000		0.000000	
Composite-High Yield				

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-
(XUTUM_CFNNTLTL)

	130/30		Long-only	
	June 1993-June 2019		June 1993-June 2019	
α_i-Alpha	0.013902		0.011116	
(t Stat.)	2.660666		2.608128	
(P Value)	0.008189	***	0.009528	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.924552		0.907314	
(t Stat.)	23.497091		28.268852	
(P Value)	0.000000		0.000000	
R^2	0.631627		0.712789	
Significance-F	0.000000		0.000000	
Composite-Quality				
α_i-Alpha	0.000978		0.001648	
(t Stat.)	0.271889		0.517967	
(P Value)	0.785881		0.604837	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.916608		0.909294	
(t Stat.)	33.852883		37.957055	
(P Value)	0.000000		0.000000	
R^2	0.780657		0.817330	
Significance-F	0.000000		0.000000	
Composite-Momentum				
α_i-Alpha	0.000350		0.001186	
(t Stat.)	0.157374		0.834657	
(P Value)	0.875049		0.404530	
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.963243		0.973931	
(t Stat.)	57.585729		90.999736	
(P Value)	0.000000		0.000000	
R^2	0.911493		0.962571	
Significance-F	0.000000		0.000000	
Composite-All Factors				
α_i-Alpha	0.004706		0.004096	
(t Stat.)	1.789716		1.854535	
(P Value)	0.074439	*	0.064577	*
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.895380		0.911257	
(t Stat.)	45.215105		54.790853	
(P Value)	0.000000		0.000000	
R^2	0.863929		0.903130	
Significance-F	0.000000		0.000000	

Table 32. Monthly Jensen's Alpha-(α_i) of Factor Investing Risk Factor Portfolios-130/30 Long-Short Alternative Strategy (Median Breakpoint)-(June 1993-June 2019)

Market Proxy- Total Return Index-
(XUTUM_CFNNTLTL)

	130/30	Long-only
	June 1993-June 2019	June 1993-June 2019

Note: *** p<0.01, ** p<0.05, * p<0.10.

CHAPTER 6

CONCLUSION

This research study's first and foremost finding is the overwhelming success of Fundamental Indexation and Factor Investing methods in generating Jensen's alpha. The majority of alphas for AHM-Fundamental Indexation for the June 2003-June 2019 period were streamlined and statistically significant, apart from the intercept for the "Trailing Five-year Average Gross Dividends" risk factor. The same trend holds for the long-term analysis period of June 1993-June 2019, only to replace the "Trailing Five-year Average Gross Dividends" risk factor with "Trailing Five-year Cash Flow" as the failing risk factor. Even though Factor Investing's overall performance is rather patchy compared to Fundamental Indexation, individual risk factors like "Gross Dividend Yield" provided an outstanding performance in June 2003-June 2019 sub-period and in June 1993-June 2019.

The June 2003 -June 2019 period stands out to be the best empirical results for excess return and statistically significant alpha generation. On the other hand, June 1993-June 2002 period has been characterized by successive boom and bust economic cycles originating from political instability, populism, and financial mismanagement. This era marked a never-ending financial turmoil and the associated investment deterring excessive real interest rates. We observe that the volatilities plaguing this sub-period have also infiltrated into the long-term analysis period of June 1993-June 2019 to distort the long-term statistical significance of portfolio returns and factor alphas.

Table 33 shows the excess return profile of each Factor over the risk-free rate and the reference market portfolio for fundamental indexation and Factor investing

portfolios for the June 2003-June 2019 period. Table 33 incorporates only the statistically significant portfolios for excess return over market proxy. Most of the excess returns for risk factors were positive, sizeable, and potent candidates for delivering positive alpha.

Table 33. Excess Return Over the Risk Free-Rate and the Reference Market Portfolio - (June 2003-June 2019)

Market Proxy-Total Return Index (XUTUM_CFNNTLTL)		
	Annual Geometric Excess Return	Annualized Geometric Mean Excess Return*
	(Portfolio Return - R_f)	(Portfolio Return - R_m)
Fundamental Indexation		
Book Value	3.96%	2.06%
Trailing Five-year Avg. Net Sales	5.48%	3.54%
Trailing Five-year Avg. Gross Dividends	6.95%	4.94%
Trailing Five-year Avg. Cash Flow	5.35%	
Composite-AHM	5.61%	3.66%
Factor Investing-Long Only (Median Breakpoint)		
Book to Price-Value	7.89%	5.87%
Net Earnings to Price-Value	8.55%	
EBIT-DA-Value	4.42%	
Total MCAP-Small Size	2.06%	
Free Float MCAP-Small Size	4.19%	
Standard Deviation-Low Volatility	7.50%	5.48%
Beta-Low Volatility	2.98%	
Gross Dividend Yield-High Yield	12.73%	10.55%
ROE-Quality	9.36%	
Trailing Five-year Avg. Earnings Growth-Quality	-3.42%	
Financial Leverage-Quality	1.72%	
Momentum-Momentum	2.25%	
Composite-Value	7.34%	5.34%
Composite-Low Size	3.16%	
Composite-Low Volatility	5.38%	
Composite-High Yield	12.73%	10.55%
Composite-Quality	3.52%	
Composite-Momentum	2.25%	
Composite-All Factors	6.07%	4.11%
Factor Investing-Long Only- (30th Percentile Breakpoint)		
Book to Price-Value	7.04%	
Net Earnings to Price-Value	7.39%	

Table 33. Excess Return Over the Risk Free-Rate and the Reference Market Portfolio - (June 2003-June 2019)

Market Proxy-Total Return Index (XUTUM_CFNNTLTL)		
	Annual Geometric Excess Return	Annualized Geometric Mean Excess Return*
	(Portfolio Return - R_f)	(Portfolio Return - R_m)
EBIT-DA-Value	3.81%	
Total MCAP-Small Size	3.33%	
Free Float MCAP-Small Size	4.68%	
Standard Deviation-Low Volatility	7.73%	5.71%
Beta-Low Volatility	4.09%	
Gross Dividend Yield-High Yield	12.61%	10.43%
ROE-Quality	8.89%	
Trailing Five-year Avg. Earnings Growth-Quality	-4.05%	
Financial Leverage-Quality	2.14%	
Momentum-Momentum	0.01%	
Composite-Value	6.64%	
Composite-Small Size	4.09%	
Composite-Low Volatility	6.14%	
Composite-High Yield	12.61%	10.43%
Composite-Quality	3.42%	
Composite-Momentum	0.01%	
Composite-All Factors	5.96%	3.99%
Total Return Index - (XUTUM_CFNNTLTL)	1.84%	
BIST-100	-0.81%	

Note: *Only statistically significant excess returns are reported.

Table 34 shows the statistically significant annualized alphas at 95% confidence level for long-only fundamental indexation and long-only and 130/30 long-short alternative strategy factor investing portfolios for June 2003-June 2019. The annualized alphas for AHM-Fundamental Indexation for June 2003-June 2019 were very close in magnitude and relatively small compared to Factor investing counterparts. Although the sizeable excess returns were somewhat trimmed, revealing the effects of the risk-adjusted element, i.e., the beta coefficient of the relevant portfolios, Jensen's alpha for all AHM-Fundamental risk factors was still substantial. The average statistically significant annualized Jensen's alpha for Fundamental Indexation portfolios for the period was 3.282% per annum. This figure is way above the distortions like transaction costs omitted in Sharpe-Lintner's CAPM

framework. If we assume the transaction costs for equity trading to hover around 0.1%, the Jensen's alpha figures for AHM-Fundamental Indexation are still sizeable even after deducting the transaction costs. Hence, they indicate the existence of unexplained abnormal returns.

On the other hand, Jensen's alpha generation in Factor Investing is somewhat inconsistent. Except for "Gross Dividend Yield" and "Standard Deviation," several Factor Investing risk factors deliver alphas with no statistical significance in June 2003-June 2019 sub-period. Nevertheless, these two risk factors have comparably outstanding statistical significance and deliver higher Jensen's alpha than their fundamental indexation counterparts. During June 2003-June 2019 period, "Gross Dividend Yield" has delivered an annual Jensen's alpha of 11.30%, while "Standard Deviation" has delivered 5.85%.

Our experiment with 130/30 long-short portfolios of Factor Investing risk factors to test whether we can enhance Jensen's alphas' statistical significance and magnitude turned out to be an outstanding success. Under the 130/30 alternative investment strategy, "Gross Dividend Yield" has delivered an annualized Jensen's alpha of 13.75%, while "Standard Deviation" has delivered 7.66%. Furthermore, the 130/30 alternative investment strategy made the "Book to Price" risk factor's alpha statistically significant to deliver a hefty annualized alpha of 7.54%. Similar to our observation in AHM-Fundamental Indexation, an even higher Jensen's alpha generation performance of Factor Investing indicates the existence of unexplained abnormal returns.

Table 34. Annualized Jensen's Alpha - (June 2003-June 2019)

Market Proxy-Total Return Index (XUTUM_CFNNTLTL)

	Annualized Jensen's Alpha-Long Only	Annualized Jensen's Alpha-130/30
Fundamental Indexation		
Book Value	2.21%	
Trailing Five-year Avg. Net Sales	3.67%	
Trailing Five-year Avg. Gross Dividends		
Trailing Five-year Avg. Cash Flow	3.50%	
Composite-AHM	3.74%	
Factor Investing-Long Only (Median Breakpoint)		
Book to Price-Value		7.54%
Net Earnings to Price-Value		
EBIT-DA-Value		
Total MCAP-Small Size		
Free Float MCAP-Small Size		
Standard Deviation-Low Volatility	5.85%	7.66%
Beta-Low Volatility		
Gross Dividend Yield-High Yield	11.30%	13.75%
ROE-Quality		
Trailing Five-year Avg. Earnings Growth-Quality		
Financial Leverage-Quality		
Momentum-Momentum		
Composite-Value	5.53%	6.12%
Composite-Low Size		
Composite-Low Volatility		
Composite-High Yield	11.30%	13.75%
Composite-Quality		
Composite-Momentum		
Composite-All Factors		5.00%
Factor Investing-Long Only (30th Percentile Breakpoint)		
Book to Price-Value		
Net Earnings to Price-Value		
EBIT-DA-Value		
Total MCAP-Small Size		
Free Float MCAP-Small Size		
Standard Deviation-Low Volatility	6.00%	
Beta-Low Volatility		
Gross Dividend Yield-High Yield	11.49%	
ROE-Quality		
Trailing Five-year Avg. Earnings Growth-Quality		
Financial Leverage-Quality		
Momentum-Momentum		
Composite-Value		

Table 34. Annualized Jensen's Alpha - (June 2003-June 2019)

Market Proxy-Total Return Index (XUTUM_CFNNTLTL)

	Annualized Jensen's Alpha-Long Only	Annualized Jensen's Alpha-130/30
Composite-Small Size		
Composite-Low Volatility		
Composite-High Yield	11.49%	
Composite-Quality		
Composite-Momentum		
Composite-All Factors		

Note: *Only statistically significant excess returns are reported.

By introducing Fama-French risk factors into the regression equations, we aimed to test whether the inclusion of Size and BE/ME factors as additional explanatory variables in the regression equation improves the functional form's statistical significance and brings in a meaningful reduction in Jensen's alpha. We have limited our work to June 2003-June 2019 sub-period in order to leave out the anomalous effects of macroeconomic adversities on Turkish financial markets during the June 1993-June 2002 sub-period. Our findings suggest that the inclusion of the SMB-(Small minus Big) and HML-(High minus Low) Portfolios in the regression equations does not improve the statistical significance and R2 of the AHM-Fundamental Indexation regression equations. It also does not induce a sizeable reduction in Jensen's alpha in any AHM-Fundamental Indexation risk factors.

In the case of Factor Investing, we observed no material improvement by including the SMB-(Small minus Big) and HML-(High minus Low) portfolios in the regression equations. The only exception is "Standard Deviation." Including Fama-French risk factors in its regression equation seems to reduce Jensen's alpha and bring in a mild improvement in R2 while staying at a 95% confidence level. Other risk factors seem to demonstrate no substantial improvement.

Table 35 shows the comparison of our findings regarding Fundamental Indexation portfolios' performance with Küçükşahin and Coşkun's (2020) study. Although the portfolio construction methodologies, the analysis period, and the selected reference market portfolio are not identical, we tried as best as possible to mimic their study in terms of the analysis period (January 2001-December 2015) and reference market portfolio. We only used the fundamental indexes identical to our study: "Book Value" and "Trailing Five-year Average Net Sales." Although the alpha figures for "Book Value" entirely differ in magnitude, the alpha for "Trailing Five-year Average Net Sales" hover close. The results also seem to look similar in terms of statistical significance.

Table 35. Monthly Jensen's Alpha-(α_i) of Fundamental Indexation-Küçükşahin and Coşkun (2020) AHM-Methodology Risk Factor Portfolios

			Küçükşahin and Coşkun	
	BIST-100		BIST-100	
	Jan 2001-Dec 2015		Jan 2001-Dec 2015	
Book Value				
α_i-Alpha	0.004		0.002	
(t Stat.)	3.438		2.660	
(P Value)	0.001	***	0.009	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.986		1.033	
(t Stat.)	97.635		93.450	
(P Value)	0.000		0.000	
R^2	0.982		0.987	
Significance-F	0.000		0.000	
Trailing Five-year Average Net Sales				
α_i-Alpha	0.004		0.005	
(t Stat.)	2.433		3.290	
(P Value)	0.016	**	0.001	***
$\beta_{iM}(R_{Mt} - R_{ft})$-Beta	0.931		0.993	
(t Stat.)	60.699		57.790	
(P Value)	0.000		0.000	
R^2	0.954		0.966	
Significance-F	0.000		0.000	

Table 35. Monthly Jensen's Alpha-(α_i) of Fundamental Indexation-Küçükşahin and Coşkun (2020) AHM-Methodology Risk Factor Portfolios

		Küçükşahin and Coşkun
	BIST-100	BIST-100
	Jan 2001-Dec 2015	Jan 2001-Dec 2015

Note: *** p<0.01, ** p<0.05, * p<0.10.

According to our findings, AHM Fundamental Indexation risk factors, as a whole, demonstrated a relatively consistent performance both in terms of excess return generation relative to Total Return Index and in the generation of positive Jensen's alpha in the June 2003-June 2019 period. On the other hand, Factor Indexing provides a handful of risk factors capable of demonstrating even superior performance than AHM-Fundamental Indexation risk factors, namely, "Gross Dividend Yield" and "Standard Deviation." Especially "Gross Dividend Yield" demonstrated a stellar performance, hinting at a significant price anomaly. Both methods may provide a means to attain long-term Jensen's alpha and perhaps become a panacea for the Turkish asset management industry ridden with a long history of negative excess returns.

APPENDIX A

COMPANY ANNOUNCEMENT EXAMPLE OF A MERGER WHERE BOTH ACQUIRER AND TARGET ARE LISTED COMPANIES

TARİH:03/08/1999

BORSA BAŞKANLIĞI DUYURUSU:

ARCLK
ARDEM
PNSUT

Arçelik A.Ş.'nin Ardem A.Ş.'yi devir alması nedeniyle, **Ardem A.Ş.**'nin Arçelik A.Ş. dışındaki ortaklarına1 Ardem = 0,8976193 Arçelik oranında verilmek üzere bastırılan hisse senetlerinin dağıtımına 04.08.1999 tarihinde başlanacaktır. Söz konusu devralma nedeniyle Ardem A.Ş. hisse senetlerinin sırası 04.08.1999 tarihinden itibaren kapatılarak kapsamında bulunduğu İMKB-Ulusal 100, İMKB-Ulusal Tüm, İMKB-Ulusal Sınai ve Metal Eşya, Makine sektör endekslerinden çıkartılacak, yerine Borsa Yönetim Kurulu'nun 08.06.1999 tarihli toplantısında 01.07.1999-30.09.1999 dönemine ilişkin olarak yedek seçilen **Pınar Süt A.Ş.** hisse senetleri İMKB-Ulusal 100 endeksine dahil edilecektir. Aynı tarihten itibaren İMKB Endeksleri'nin hesaplamalarında Arçelik A.Ş. hisse senetlerinin Takasbank saklama oranı %20 olarak dikkate alınacaktır. Arçelik A.Ş.'nin, Ardem A.Ş.'yi devir alması sonrası oluşan 21.520 milyar TL çıkarılmış sermayesinin %60 bedelsiz artırılarak 34.432 milyar TL'ye yükseltilmesi ve yine 21.520 milyar TL sermayeyi temsil eden hisse senetlerine %20 oranında nakit kar payı dağıtılması işlemlerine 04.08.1999 tarihinden itibaren başlanacağından, Arçelik hisse senetlerinin 04.08.1999 tarihinde Birinci Seansdaki baz fiyatı 12.821 TL olarak tespit edilmiştir.

APPENDIX B

COMPANY ANNOUNCEMENT EXAMPLE OF A MERGER WHERE THE ACQUIRER IS A LISTED COMPANY BUT THE TARGET IS AN UNLISTED ONE

TARİH:30/12/2005

CMENT **Çimentaş İzmir Çimento Fabrikası Türk A.Ş.**'nin 30.12.2005 tarihli yazısı aşağıya çıkarılmıştır. "**Konu:** Sermaye Piyasası Kurulu'nun Seri:VIII, No: 39 sayılı Tebliği uyarınca yapılan açıklamadır. Tasasrruf Mevduatı Sigorta Fonu (TMSF) tarafından 10.10.2005 tarihinde yapılan açık artırma sonucunda, Şirketimiz tarafından ihalesi kazanılan "Lalapaşa Çimento İktisadi ve Ticari Bütünlüğü"nün Şirketimize satış ve devrine ilişkin izin ve diğer ön işlemler tamamlanmış, ihale satış bedeli olan 166.500.000 ABD Doları tutar TMSF'ye ödenmiş, Devir ve Teslim Sözleşmesi akdedilerek tüm devir işlemleri tamamlanmıştır. Söz konusu ihale bedelinin 50.000.000 ABD Dolarlık kısmı yabancı ortaklarımızdan CEMENTİR SpA tarafından ileriki bir tarihte yapılacak ve ancak henüz karara bağlanmamış sermaye artırımı işleminde kullanılmak üzere "sermaye avansı" olarak gönderilen miktardan karşılanmıştır.

APPENDIX C

COMPANY ANNOUNCEMENT EXAMPLE OF A MERGER WHERE THE ACQUIRER IS AN UNLISTED COMPANY BUT THE TARGET IS A LISTED ONE

TARİH: 19/07/2002

BORSA BAŞKANLIĞI DUYURUSU:

ENKA
ENKAI

Enka Holding Yatırım A.Ş. (Enka Holding)'nin, Kurumlar Vergisi Kanunun 37., 38. ve 39. maddeleri ile Türk Ticaret Kanunun 451. ve ilgili diğer hükümleri çerçevesinde, **Enka İnşaat ve Sanayi A.Ş.** (Enka İnşaat) tarafından tüm aktif ve pasifiyle birlikte devralınarak Enka İnşaat bünyesinde birleşmesi nedeniyle, Enka İnşaat tarafından ihraç edilecek ve Enka Holding ortaklarına verilecek hisse senetlerinin dağıtımına 22.07.2002 tarihinden itibaren başlanacaktır.

Bu nedenle,

22.07.2002 tarihinde "ENKAI" koduyla Borsamız Ulusal Pazarı'nda serbest marjla işlem görmeye başlayacak olan Enka İnşaat'ın 22.07.2002 tarihinde birinci seansta referans olarak alınabilecek fiyatı, Enka Holding hisse senetlerinin en son işlem gördüğü ikinci seans ağırlıklı ortalama fiyatı olan 112.498 TL'nin, 1 adet Enka Holding hisse senedi karşılığında verilecek olan Enka İnşaat hisse senedi sayısına (1,1382 adet) bölünmesi suretiyle bulunan 98.839 TL olacaktır. Devralan şirket Enka İnşaat, İMKB Hisse Senetleri Piyasası Endeksleri Temel Kuralları'nın 5.6 maddesi gereğince Enka Holding'in kapsamında bulunduğu İMKB Ulusal-30, İMKB Ulusal-50, İMKB Ulusal-100 ve İMKB Ulusal-Tüm endeksleri kapsamında kalacak; ayrıca 22.07.2002 tarihinden itibaren sırası kapatılacağından Enka Holding İMKB Ulusal-Mali

ile Holding ve Yatırım sektör endekslerinden çıkarılacak, Enka İnşaat ise İMKB Ulusal-Hizmetler endeksi kapsamına dahil edilecektir.

22.07.2002 tarihinden itibaren İMKB Endeksleri'nin hesaplamalarında Enka İnşaat'ın sermayesi 22.564.654 milyon TL, Takasbank saklama oranı %11 olarak dikkate alınacaktır.

APPENDIX D

COMPANY ANNOUNCEMENT EXAMPLE OF A SQUEEZE-OUT TRANSACTION

TEBNK – Türk Ekonomi Bankası A.Ş.

AÇIKLAMA:

Sermaye Piyasası Kurulu'nun II-27.2 sayılı "Ortaklıktan Çıkarma ve Satma Hakları Tebliği" kapsamında devam etmekte olan ortaklıktan çıkarma süreci çerçevesinde hakim ortaklarımızdan BNP Paribas Fortis Yatırımlar Holding A.Ş.'ye tahsisli olarak yapılacak sermaye artırımı amacıyla hazırlanan ve Sermaye Piyasası Kurulu tarafından onaylanan ihraç belgesinin 23.06.2015 tarihinde tescil işlemi tamamlanmış olup, II-27.2 No'lu Ortaklıktan Çıkarma ve Satma Hakları Tebliğ uyarınca, hakim ortak dışında kalan ortakların payları, tescil tarihi itibarıyla iptal edilmiş sayılacaktır.

REFERENCES

Ang, A., Goetzmann W., & Schaefer S.. (2009). Evaluation of active management of the norwegian government pension fund-global. Report to the Norwegian Ministry of Finance.

Arnott, R.D., Hsu J.C., & Moore P. (2005). Fundamental indexation. *Financial Analysts Journal*, *61*(2), 83-99. https://doi.org/10.2469/faj.v61.n2.2718

Banz, R.W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics*, *9*(1), 3-18. https://doi.org/10.1016/0304-405X(81)90018-0

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*, *32*(3), 663-682.

Bender, J., Briand R., Melas D., & Subramanian R.A. (2013). Foundations of factor investing. *MSCI Research Insight*, December 2013.

Bhandari, L.C. (1988). Debt/equity ratio and expected common stock returns:Empirical evidence. *Journal of Finance, 43*(2), 507-28.

Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of Business*, *45*(3), 444-54.

Black, F., Jensen M.C., & Scholes M. (1972). The capital asset pricing model: Some empirical tests. *Studies in the theory of capital markets*. Michael C. Jensen, ed. New York: Praeger, 79-121.

Brière M., Chapelle A., & Szafarz A.. (2012) No contagion, only globalization and flight to quality. *Journal of International Money and Finance*, *31*(6), 1729-1744.

Carhart, M.M. (1997). On persistence in mutual fund performance. *Journal of Finance*, *52*(1), 57-82.

Fama, E.F., & French K.R. (1992). The cross-section of expected stock returns. *Journal of Finance*, *47*(2), 427-65.

Fama, E.F., & French K.R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3-56.

Fama, E.F., & French K.R. (1995). Size and book-to-market factors in earnings and returns. *Journal of Finance*, *50*(1), 131-55.

Fama, E.F., & French K.R. (1996). Multifactor explanations of asset pricing anomalies. *Journal of Finance*, *51*(1), 55-84.

Fama, E.F.,French. (1998). Value versus growth: The international evidence. *Journal of Finance*, *53*(6), 1975-999.

Fama, E.F., & French K.R. (2004). The capital asset pricing model: Theory and evidence. *Journal of Economic Perspectives*, *18*(3), 25-46.

Fama, E.F., & French K.R. (2015). A five-factor asset pricing model. *Journal of Financial Economics*, *116*(1), 1-22.

Gibbons, M.R. (1982). Multivariate tests of financial models: A new approach. *Journal of Financial Economics*, *10*(1), 3-27.

Gibbons, M.R., Ross, S.A., & Shanken. (1989). A test of the efficiency of a given portfolio. *Econometrica*, *57*(5), 1121-152.

Jegadeesh, N. & Titman S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *Journal of Finance*, *48*(1), 65-91.

Jensen, M.C. (1968). The performance of mutual funds in the period 1945–1964. *Journal of Finance*, *23*(2), 389–416.

Jobson ,J.D., & Korkie, B. (1982). Potential performance and tests of portfolio inefficiency. *Journal of Financial Economics, 10*, 433-466.

Kandel, S., & Stambaugh, R.F. (1987). On correlations and inferences about mean-variance efficiency. *Journal of Financial Economics*, *18*, 61-90.

Küçükşahin, H., & Coşkun, E. (2020). The performance of fundamental indexes: An application on Istanbul. *Ege Academic Review, 20*(1), 1-19.

Loughran, T., Ritter J.R. (1995). The new issues puzzle. *Journal of Finance, 50*(1), 23-51.

Lakonishok, J., & Shapiro A.C. (1986). Systematic risk, total risk, and size as determinants of stock market returns. *Journal of Banking and Finance, 10*(1), 115–32.

Lakonishok, J., Shleifer A., & Vishny R.W. (1994). Contrarian investment, extrapolation, and risk. *Journal of Finance, 49*(5), 1541-578.

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, 47*(1), 13-37.

MacKinlay, A.C., & Richardson, M.P. (1991). Using generalized method of moments to test mean-variance efficiency. *Journal of Finance, 46*, 511-527.

Markowitz, H. (1952). Portfolio selection. *Journal of Finance, 7*(1), 77-99.

Mayers, D. (1976). Nonmarketable assets, market segmentation, and the level of asset prices. *The Journal of Financial and Quantitative Analysis*, 11(1), 1-12.

Mitchell, M.L., Stafford, E. (2000). Managerial decisions and long-term stock price performance. *Journal of Business, 73*(3), 287-329.

Reinganum, M.R. (1981). A new empirical perspective on the CAPM. *Journal of Financial and Quantitative Analysis, 16*(4), 439-62

Roll, R., & Ross S.A. (1994). On the cross-sectional relation between expected returns and betas. *Journal of Finance, 49*(1), 101–121.

Rosenberg, B., Marathe, V. (1976). Common factors in security returns: Microeconomic determinants and macroeconomic correlates. *Research program in finance working papers*. University of California at Berkeley, No. 44.

Rosenberg, B., Reid K., & Lanstein R. (1985). Persuasive evidence of market inefficiency. *Journal of Portfolio Management, Spring,* 11, 9–17

Ross, S.A. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, *13*(3), 341–60.

Ross, S.A. (1978). The current status of the capital asset pricing model (CAPM). *The Journal of Finance, 33*(3), 885-901.

Shanken, J. (1985). Multivariate tests of the zero-beta CAPM. *Journal of Financial Economics*, 14(3), 327-348.

Sharpe, W.F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance, 19*(3), 425–42.

Stambaugh, R.F. (1982). On the exclusion of assets from tests of the two-parameter model: A sensitivity analysis. *Journal of Financial Economics*, *10*(3), 237-68

Statman, D. (1980). Book values and stock returns. *The Chicago MBA: A Journal of Selected Papers*, 4, 25-45

Treynor, J.L. (1961). Market value, time, and risk. Reprinted manuscript. https://dx.doi.org/10.2139/ssrn.2600356

Zhou, G. (1991). Small sample tests of portfolio efficiency. *Journal of Financial Economics*, 30, 165-191.