BUFFET'S INVESTMENT STYLE : EVIDENCE FROM THAI STOCK MARKET

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ABSTRACT

This paper examines the validity of beta factor in Thai stock market returns. Using the five-factors include the market factor (market risk premium, MKT), the size factor (small market capitalization minus big market capitalization, SMB), the book-to-market factor (high book-to-market equity ratio minus low book-to-market equity ratio, HML), the momentum factor (winners minus losers, WML) and beta factor (BAB). Our data cover stocks traded in the Stock Exchange of Thailand (SET100) from February 2003 to February 2012. Monthly excess stock returns are computed from nine testing portfolios based on size and book-to-market ratios. Time series regressions following Fama and French (1992) are employed to test the five-factor model on these nine testing portfolios.

The test result shows that the Gibbons-Ross-Shanken (GRS) statistic reject the null hypothesis of zero alphas (risk-adjusted excess return) in every model. However, the BAB augmented 4-factor model has the highest adjusted-R2 value compared to other models. In conclusion, the BAB augmented 4-factor model is the best model to explain the stock returns but the beta factor is not a significant factor to explain average excess stock returns in the Thai stock market.

Following Frazzini and Pederson (2014) we find that a BAB factor earns significant positive returns and stocks with higher volatility earn relatively lower returns. Our results are similar to those found in the US (Frazzini & Pederson, 2014) and India (Agarwalla, Jacob, Varma, & Vasudevan, 2014).

KEY WORDS: BETTING AGAINST BETA/ BAB FACTOR / THAI STOCK RETURN

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CHAPTER I
INTRODUCTION

Beta plays an important role in influencing asset prices but it is difficult to define. However, Investors consider beta to be an important factor when making their investment decisions due to the restriction in there leverage. Thus, the issue of beta in asset pricing has become the issue that attracted considerable attention from researchers during past two decades.

Black (1993) was the first to point out the relative flatness of the Security Market Line (SML) when compared to the CAPM prediction. Frazzini and Pederson (2014) later re-examine this issue and argue that unlike in the standard CAPM assumptions, investors actually face the borrowing restrictions and this explains the flatness. Their empirical evidences suggest that the relative flatness of the security market line is widespread in the world.

They develop a beta factor in the lines of Black (1993), called the "Betting Against Beta" (BAB) factor. They find that the BAB factor earns significant returns using data from 20 international equity markets, Treasury bond markets, credit markets, and futures markets. Moreover, they find that more leverage constrained investors hold high-beta portfolios and the less constrained ones hold low-beta portfolios.

Empirical evidence on the beta–return relation mainly investigated in US and developed countries markets. However, the study of this relation in emerging markets is still rarely done. Therefore, this study will investigate the relation of beta and return in Stock Exchange of Thailand (SET), an emerging market. The main aim of this study is to investigate whether beta has significant effect on stock returns in the Stock Exchange of Thailand (SET).

This study will employed the traditional CAPM model, Fama-French three factor model, Carhart four factor model and BAB augmented 4-factor model to investigate the role of beta in Thai stock returns. The data used in this study is 100 listed stocks in the SET100 Index from February 2003 to February 2012.

Our results show that adding the beta factor to the model can increase the average adjusted-R2 and the number of significant intercepts is reduced. The BAB augmented 4-factor model has more explanatory power than the traditional CAPM model, Fama-French three-factor model and Carhart four-factor model. However, the regression results suggest that beta factor might not be an important factor in asset pricing models.

Our results also reveal that Betting Against Beta (BAB) portfolio earns significant positive returns. More specifically, the portfolios of high beta stocks have lower alphas and lower Sharpe ratios compared to portfolios of low beta stocks.

This paper is organized in the following manner. Section 1 is an introduction. Section 2 reviews prior research. Section 3 explains methodology. Section 4 discusses data and provides descriptive statistics. Section 5 provides empirical results. Lastly, section 6 provides conclusions and implications of this research.

CHAPTER II
THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Definition

2.1.1 Capital Asset Pricing Model (CAPM)

CAPM builds on the model of portfolio choice developed by Sharpe (1964) identifies an expected return on securities. It suggested that asset with higher risk will give a higher expected return. However, risk can be reduced by forming a well-diversified portfolio. Therefore, the total risk will be eliminated to the only non-diversifiable risk, known as "Systematic risk" which is measured by beta coefficient. CAPM is defined by the following equation.

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

The $E(R_i)$ is an expected is return of stock i, $E(R_m)$ is an expected return of the market portfolio, R_f is the risk-free rate, and β_i is a measure of non-diversifiable risk of stock i.

2.1.2 Fama-French three-factor model

Fama and French (1992) argues that only one variable factor is not enough to describe the returns of a portfolio. They start to find out the factors which can explain returns of stock portfolios.

Fama–French model expand the CAPM by adding the Size factor known as "Small Minus Big" (SMB) and the Value factor known as "High Minus Low" (HML). The three-factor model is defined by the following equation.

$$E(R_i) - R_f = \beta_i\big(E(R_m) - R_f\big) + s_i(SMB) + h_i(HML)$$

The s_i is the sensitivity of the asset returns to return of SMB and SMB is the difference between average returns of small capitalized stock portfolios and average returns of big capitalized stock portfolios. The h_i is the sensitivity of the asset returns to return of HML and HML is the difference between average returns of high book-to-market stock portfolios and average returns of low book-to-market stock portfolios.

2.1.3 Carhart four-factor model

Carhart (1997) developed four-factor model using Fama-French three-factor model plus an additional Momentum factor, known as "Winner Minus Loser (WML)" to explain the return of an asset. Carhart four-factor model is defined by the following equation.

$$E(R_i) - R_f = \beta_i(R_m - R_f) + s_i(SMB) + h_i(HML) + w_i(WML)$$

The w_i is the sensitivity of the asset returns to return of WML and WML is the difference between average returns of the winner stock portfolios and returns of the loser stock portfolios.

Momentum is described as the tendency for the stock price to continue rising if it is going up and to decrease if it is going down. It can be calculated by subtracting the equal weighted average of the highest performing firms from the equal weighed average of the lowest performing firms, lagged one month (Carhart, 1997).

2.1.4 Betting against beta

Frazzini and Pederson (2014) propose the equilibrium required return for any securities when some investors face leverage constraints. The required return is defined by the following equation.

$$E_t(R^s_{t+1}) = R^f + \psi_t + \beta^s_t \lambda_t$$

The risk premium is $\lambda_t = E_t(r^M_{t+1}) - R^f - \psi_t$ and ψ_t is the average Lagrange multiplier measuring the tightness of funding constraints.

They develop a beta factor in the lines of Black (1993), called the "Betting against beta (BAB)". To construct the BAB factor, we form the portfolio with long low-beta stocks and short high-beta stocks. Let W_L be the relative portfolio weights for a portfolio of low-beta assets with return $r_{t+1}^{L} = W_L r_{t+1}$ and consider similarly a portfolio of high-beta assets with return r_{t+1}^{H}. The betas of these portfolios are denoted β_t^L and β_t^H , where $\beta_t^L < \beta_t^H$. We construct a betting against beta (BAB) factor by the following equation.

$$r_{t+1}^{BAB} = \frac{1}{\beta_{t+1}^{L}}(r_{t+1}^{L} - r^{f}) - \frac{1}{\beta_{t+1}^{H}}(r_{t+1}^{H} - r^{f})$$

This portfolio is market neutral. It has a beta of zero (Black's CAPM). The long side has been leveraged and another side has been de-leveraged.

2.2 Literature review

Black (1972) explores the nature of capital market equilibrium under two assumptions that are more restrictive than usual assumptions used in deriving the capital asset pricing model. He found that the expected return on any risky asset is a linear function without any restrictions on borrowing. In Black (1993), he again investigates the relation between beta and return and conclude that rational investors who can borrow freely, whether individuals or firms, should continue to use the CAPM and beta to value investments and to choose portfolio strategy.

Fama and French (1992) finds that size and book-to-market equity ratio (BE/ME) can also explain cross-sectional variation in average stock returns. In the subsequent work, Fama and French (1996) shows that the effects of firm characteristic variables, previously found to be related to average returns, such as earnings/price, cash flow/price, and past sales growth, largely disappear in the three-factor model. Later, Carhart (1997) adds the momentum factor to the three-factor model.

Fama and French (2012) apply the four-factor model to examine stock returns in four regions: North America, Europe, Japan, and Asia Pacific. They find that value premiums decrease with size (except in Japan). There is the return momentum everywhere (again except in Japan) and spreads in the average momentum returns also decrease with size.

Frazzini and Pederson (2014) find that the BAB factor earns significant returns using data from 20 international equity markets, treasury bond markets, credit markets, and future markets. Moreover, portfolios of high-beta assets have lower alphas and Sharpe ratios than portfolios of low-beta assets. On the other hand, portfolios of high-beta assets have higher volatility than portfolios of low-beta assets. They find that Security Market Line (SML) is not only flatter than predicted by the standard CAPM for U.S. equities, but they also find this relative flatness in 18 of 19 international equity markets, in Treasury markets, for corporate bonds sorted by maturity and by rating, and in futures markets. Agarwalla et al. (2014) find that a similar BAB factor earns significant positive returns in India. Stocks with higher volatility also earn relatively lower returns.

In the case of Thai stock returns, Ruzhe (2004) confirmed that Fama-French model can explain Thai stock returns better than the standard CAPM.

CHAPTER III
METHODOLOGY

3.1 BAB augmented 4-factor model

The empirical model of our study is the BAB augmented 4-factor model which can be written as the following equation.

$$E(R)_i - R_f = \alpha_i + \beta_i(R_m - R_f) + s_i(SMB) + h_i(HML) + w_i(WML) + b_i(BAB)$$

The α_i is the intercept and is supposed to be zero if all the factors can explain the excess returns. The b_i is the sensitivity of the stock returns to the return of BAB and BAB is the difference between the average returns of long low-beta stocks and short high-beta stocks.

3.2 Econometric method

To examine whether the asset pricing models can capture the expected stock returns, we will employ the time-series regression to all equations. Then, we will employ the Gibbons-Ross-Shanken (GRS) test (Gibbons, Ross, & Shanken, 1989) to test all the pricing errors (intercepts). If the asset pricing models can explain the expected return completely, all the regression intercepts (α_i) should be jointly equal to zero (Cochrane, 2005).

3.3 Factors

3.3.1 Market Risk Premium ($R_m – R_f$)

The market risk premium is an excess return of the market portfolio over a risk-free rate. In this paper, we use SET index as our market portfolio. Its raw return is computed monthly from the Total Return Index which includes the effects of price movements (capital gain/loss), rights offered to current shareholders allowing them to purchase additional shares, usually at a discount to market price (rights offering), and income from dividend payments (dividends) assuming they are reinvested in securities. The risk-free rate is measured by the one-month yield to maturity of Treasury bill at the beginning of each month.

3.3.2 Size factor and value factor (SMB and HML)

We use the data at the end of February of each year from February 2003 to February 2012 in constructing size and value factor. For constructing size factor, we rank all firms on size, measured by market capitalization at the end of February. For constructing value factor, we rank all firms on book-to-market ratio [(Book value per share of February year t) / (Stock price of December year t-1)] using fiscal year ending data.

The size factor is split by median into two groups: small stocks (S) and big stocks (B). The value factor is split into three groups: low (L), medium (M) and high (H) book-to-market ratio by using 30^{th} and 70^{th} percentiles as breaking points (stocks in L group are below 30^{th} percentiles and stocks in H group are above 70^{th} percentiles). Then, six portfolios are formed at the intersection of size and book-to-market ratio as shown in diagram 1.

We calculate the market capitalization of each firm by using value-weighted return. These six portfolios are annually rebalanced at the end of February.

Diagram 1: SMB and HML portfolio formation

		Size (Market Capitalization)	
		B(50)	S(50)
B/M	H(30)	BH	SH
(Book-to-Market Ratio)	M(40)	BM	SM
	L(30)	BL	SL

Note:

B represents the securities group in the first 50th percentile which has the big size of market capitalization.
S represents the securities group in the 50th percentile which has the small size of market capitalization.
H represents the securities group in the first 30th percentile which has the high value of book-to-market ratio.
M represents the securities group in the 40th percentile which has the medium value of book-to-market ratio.
L represents the securities group in the 30th percentile which has the low value of book-to-market ratio.
BH represents the securities group which has the big size of market capitalization and high value of book-to-market ratio.
BM represents the securities group which has the big size of market capitalization and medium value of book-to-market ratio.
BL represents the securities group which has the big size of market capitalization and low value of book-to-market ratio.
SH represents the securities group which has the small size of market capitalization and high value of book-to-market ratio.
SM represents the securities group which has the small size of market capitalization and medium value of book-to-market ratio.
SL represents the securities group which has the small size of market capitalization and low value of book-to-market ratio.

SMB (Small Minus Big) is a **size factor** as measured by a market capitalization. The SMB is a difference between average returns of small stock portfolio (SH, SM and SL) and big stock portfolio (BH, BM and BL). The SMB is calculated by the following equation.

$$SMB = \frac{1}{3}(r_{SL} + r_{SM} + r_{SH}) - \frac{1}{3}(r_{BL} + r_{BM} + r_{BH})$$

HML (High Minus Low) is a **value factor** as measured by a book-to-market ratio. The HML is a difference between average returns of high book-to-market stock portfolio (SH and BH) and low book-to-market stock portfolio (SL and BL). The HML is calculated by the following equation.

$$HML = \frac{1}{2}(r_{SH} + r_{BH}) - \frac{1}{2}(r_{SL} + r_{BL})$$

3.3.3 Momentum factor (WML)

We are constructing momentum factor by ranking stocks based on their past cumulative 11-month returns (included dividend), except one month. For example, we ranked the return of January to November last year. Next, we monthly formed two equal-weighted portfolios (the winner and the loser). The winner portfolio includes 30 percent of stocks with the highest past return, while the loser portfolio includes 30 percent of stocks with the lowest past return as shown in diagram 2.

Diagram 2: WML portfolio formation

Past Cumulative	Winner	(30)	W
11-month return		(40)	-
	Loser	(30)	L

Note:

W represents the securities group in the first 30th percentile which has the highest past cumulative 11-month return (Winner).

L represents the securities group in the last 30th percentile which has the lowest past cumulative 11-month return (Loser).

The WML is a difference between average returns of the Winner stock portfolio and average returns of the Loser stock portfolio. WML is calculated by the following equation.

$$WML = r_w - r_l$$

Where r_w is return of Winner stock portfolio and r_l is return of Loser stock portfolio.

3.3.4 Betting against beta

The pre-ranking stock betas are estimated with annualized volatility of daily return for the latest date of the selection period. We use the following approach for beta estimation.

$$E(R)_i = \alpha_i + \beta_i(R_m)$$

Where $E(R)_i$ is an expected return of stock i, α_i is the intercept of the model, β_i is a coefficient of systematic risk of stock i and R_m is an expected return of the market portfolio.

The portfolio weights w_i of each stock are calculated by

$$w_i = k(z - \bar{z})$$

"k" is a normalizing constant and $k = 2/1'_n|z - \bar{z}|$. "z" is the n x 1 vector of beta ranks $z_i = rank = (\beta_i)$ at portfolio formation, and $\bar{z} = 1'_n z/n$ be the average rank, "n" is the number of securities and 1_n is n x 1 vector of ones.

We follow the methodology of Frazzini and Pederson (2014) to construct the BAB factor. First, all securities are ranked in ascending order on the basis of their estimated beta. For each month t+1, the securities are divided into two groups (portfolios) based on their ranked beta values at t. The portfolio above (below) the median is called the high beta (low beta) portfolio as shown in diagram 3.

Diagram 3: BAB portfolio formation

LB	(50)	Low Beta
HB	(50)	High Beta

Note:

LB represents the securities group in the last 50th percentile which has the beta value below the median.
HB represents the securities group in the first 50th percentile which has the beta value above the median.

The BAB factor returns are estimated as below.

$$r_{t+1}^{BAB} = \frac{1}{\beta_t^L}(r_{t+1}^L - r^f) - \frac{1}{\beta_t^H}(r_{t+1}^H - r^f)$$

Where β_t^L is the weighted average beta of the low beta portfolio, β_t^H is the weighted average beta of the high beta portfolio, r_{t+1}^L is the weighted returns on the low beta portfolio, r_{t+1}^H is the weighted returns on the high beta portfolio and r^f is the risk-free rate.

The return of the betting-against-beta (BAB) portfolio is a portfolio that is long leveraged low beta stocks and that short-sells de-leveraged high beta stocks. The BAB factor returns are estimated only for a period from February 2003 to February 2012. The portfolios are rebalanced every calendar month.

Frazzini and Pederson (2014) find empirically that portfolios of high beta assets have lower alphas and Sharpe ratios than portfolios of low beta assets. The returns on the BAB factor dominate the returns on the size, value and momentum factors. Then, we classify five beta-sorted portfolios. Portfolios P1 to P5 are equally weighted portfolios constructed based on beta-sorted portfolios at the beginning of each calendar month and the portfolios are rebalanced every month to maintain equal weights. In the meantime, portfolios P1 to P5 are ranked in ascending order on the basis of their estimated beta at the end of the previous month. The five testing beta-sorted portfolios are shown in diagram 4.

Diagram 4: Beta-sorted portfolio formation

P1	(20)	Low Beta
P2	(20)	
P3	(20)	
P4	(20)	
P5	(20)	High Beta

Note:

P1 represents the securities group in the first 0% - 20% of ranking beta which has low beta.
P2 represents the securities group in the first 21% - 40% of ranking beta which has low to market beta.
P3 represents the securities group in the first 41% - 60% of ranking beta which has market beta.
P4 represents the securities group in the first 61% - 80% of ranking beta which has market to high beta.
P5 represents the securities group in the first 81% - 100% of ranking beta which has high beta.

We also examine that the BAB factor returns to various anomalies including, size, value and momentum by following to the equation below;

$$b_i(BAB) = \alpha_i + \beta_i(R_m - R_f) + s_i(SMB) + h_i(HML) + w_i(WML)$$

Where $b_i(BAB)$ is the return of five beta-sorted portfolios (P1-P5) and BAB portfolio.

3.3.5 Testing portfolio formation

Testing if the BAB augmented 4-factor model explain excess stock returns, we form testing portfolios or dependent variables. Following Fama and French (1993), we use excess returns on value-weighted portfolios formed on the basis of size factor and value factor. The nine testing portfolios are shown in diagram 5.

Diagram 5: Performance portfolio formation

		Size (Market Capitalization)		
		B (30)	N (40)	S (30)
B/M	H (30)	TBH	TNH	TSH
(Book-to-Market Ratio)	M (40)	TBM	TNM	TSM
	L (30)	TBL	TNL	TSL

Note:

B represents the securities group in the first 30th percentile which has the big size of market capitalization.

N represents the securities group in the 40th percentile which has the normal size of market capitalization.

S represents the securities group in the 30th percentile which has the small size of market capitalization.

H represents the securities group in the first 30th percentile which has the high value of book-to-market.

M represents the securities group in the 40th percentile which has the medium value of book-to-market.

L represents the securities group in the 30th percentile which has the low value of book-to-market.

TBH represents the securities group which has the big size of market capitalization and high value of book-to-market.

TBM represents the securities group which has the big size of market capitalization and medium value of book-to-market.

TBL represents the securities group which has the big size of market capitalization and low value of book-to-market.

TNH represents the securities group which has the medium size of market capitalization and high value of book-to-market.

TNM represents the securities group which has the medium size of market capitalization and medium value of book-to-market.

TNL represents the securities group which has the medium size of market capitalization and low value of book-to-market.

TSH represents the securities group which has the small size of market capitalization and high value of book-to-market.

TSM represents the securities group which has the small size of market capitalization and medium value of book-to-market.

TSL represents the securities group which has the small size of market capitalization and low value of book-to-market.

CHAPTER IV
DATA

SET100 index, stock price and beta are collected from the SETSMART database. The sample consists of stocks listed in SET100 index between February 2003 and February 2012. Calculation of stock returns is based on Total Returns, which adjust for stock repurchases, rights offering, and dividends. Because SET100 index was launched in 2005, our sample use the same set of stocks from 2002 to 2004 based on stocks listed in SET100 in 2005.

Risk-free rates are collected from one-month yield to maturity of Treasury bill at the beginning of each month. The data are collected from the Thai Bond Market Association (TBMA)'s iBond database.

4.1 Descriptive Statistics

4.1.1 Factors

Table 4.1 reveals that average monthly excess return of the Big stock portfolio (High market capitalization) is higher than the Small stock portfolio (Low market capitalization) (2.13% vs. 1.68%). The Growth stock portfolio (Low book-to-market ratio) has the higher average monthly excess return than the Value stock portfolio (High book-to-market ratio) (3.40% vs. 0.82%).

These results are in contrast to those of North American and Japanese markets, in which big and growth stock portfolios have less excess return than the small and value stock portfolios. However, they are similar to the results from Europe, China and Asia Pacific markets (See Fama and French (2012), Davivongs and Pavabutr (2012), Agarwalla et al. (2014)).

Table 4.1: Average monthly excess return of each factor portfolio

(Unit percent per month)

	Portfolio	B	S	Avg
(Value)	H	1.11	0.53	0.82
	M	1.84	1.15	1.49
(Growth)	L	3.44	3.37	3.40
	Avg	2.13	1.68	

Note: average monthly market excess return = 1.13%

Table 4.2 presents the risk of each portfolio, measured by standard deviation of monthly excess return. It shows that the big stock portfolio has lower risk than the small stock portfolio (8.56% vs. 9.75%). The Growth stock portfolio has higher risk than Value stock portfolio (9.51% vs. 9.01%).

Table 4.2: Standard deviation of monthly excess return of each factor portfolio

(Unit percent per month)

	Portfolio	B	S	Avg
(Value)	H	8.43	9.60	9.01
	M	7.74	10.14	8.94
(Growth)	L	9.50	9.51	9.51
	Avg	8.56	9.75	

Note: standard deviation of monthly market excess return = 6.88%

Table 4.3 draws a comparison between each portfolio's performances on the risk-adjusted return basis as measured by the Sharpe ratio. The result shows that the Sharpe ratio of big stock portfolio ratio is higher than that of the Small stock portfolio (0.84 vs. 0.60). The Growth stock portfolio beats the Value stock portfolio also on the risk-adjusted return (1.24 vs. 0.32).

Table 4.3: Sharpe Ratio of monthly excess return of each factor portfolio

	Portfolio	B	S	Avg
(Value)	H	0.45	0.19	0.32
	M	0.82	0.39	0.61
(Growth)	L	1.25	1.23	1.24
	Avg	0.84	0.60	

Note: sharpe ratio of monthly market excess return = 0.57%

Table 4.4 presents an average monthly excess return, standard deviation of monthly excess return and Sharpe ratio of both Winner and Loser stock portfolios when compared to those of the market.

The Winner stock portfolio has higher average monthly excess return than Loser stock portfolio (2.62% vs. 1.79%). Although, The Winner stock has a higher risk than Lower stock (8.96% vs. 8.66%) but the performances on the risk-adjusted return basis measured by the Sharpe ratio of the Winner stock portfolio clearly beat the Loser stock portfolios (1.01 vs. 0.72).

Table 4.4: Average monthly excess return, standard deviation and Sharpe ratio of Winner and Loser portfolio

(Unit: percent per month, except unit of Sharpe ratio which has no unit)

	W	L	Market
Average excess return	2.62	1.79	1.13
Standard deviation	8.96	8.66	6.88
Sharpe ratio	1.01	0.72	0.57

These findings (average monthly excess return, standard deviation of monthly excess return and Sharpe Ratio of monthly excess return of each factor portfolio) are similar to those reported in Pongsuwan et al. (2014) (See table 17 in the appendix). However, their returns only measure capital gain or loss, whereas ours are Total Return.

Table 4.5 presents an average monthly excess return, standard deviation of monthly excess return and Sharpe ratio of both Low beta and High beta stock portfolios when compared to those of the market.

Table 4.5: Average monthly excess return, standard deviation and Sharpe ratio of Low beta and High beta portfolio

(Unit: percent per month, except unit of Sharpe ratio which has no unit)

	LB	HB	Market
Average excess return	1.96	1.19	1.13
Standard deviation	6.93	10.19	6.88
Sharpe ratio	0.98	0.40	0.57

The low beta portfolio has higher average monthly excess return than high beta portfolio (1.96% vs. 1.19%). The high beta portfolio has a higher risk than low beta portfolio but earn lower risk-adjusted return basis measured by the Sharpe ratio (0.98 vs. 0.40).

Table 4.6 presents correlations of monthly excess returns of each factor portfolio. It shows that all factor portfolios have high correlations with the market. It also reveals that the Small and Growth stock portfolio (SL) has a lowest correlation with the market (0.70) and all other factor portfolios. On the other hand, the Big and Growth stock portfolio (BM) has a highest correlation with the market (0.92).

Table 4.6: Correlation matrix of monthly excess returns of factor portfolios

	Market	BH	BM	BL	SH	SM	SL	W	L	LB	HB
Market	1										
BH	0.88	1									
BM	0.92	0.89	1								
BL	0.86	0.72	0.80	1							
SH	0.83	0.80	0.81	0.64	1						
SM	0.86	0.82	0.82	0.72	0.90	1					
SL	0.70	0.65	0.63	0.59	0.76	0.80	1				
W	0.79	0.69	0.73	0.84	0.67	0.73	0.61	1			
L	0.88	0.87	0.89	0.73	0.86	0.86	0.71	0.65	1		
LB	0.91	0.85	0.87	0.82	0.90	0.90	0.79	0.80	0.86	1	
HB	0.89	0.85	0.87	0.72	0.92	0.92	0.78	0.71	0.90	0.90	1

Table 4.7 provides the average monthly return, Standard deviation of monthly return and Sharpe ratio of MKT, SMB, HML, WML and BAB.

We find that SMB has negative average monthly return. This means small stock portfolios have less average returns than big stock portfolios, making SMB negative. HML also has a negative average return. This is because value stock portfolios have less average returns than growth stock portfolios, making HML negative. The overall results indicate that in the Thai stock market, big and growth stock portfolios outperform small and value stock portfolios. This is in sharp contrast to the results from the US markets which have positive average returns of both SMB and HML (Fama & French, 1992).

WML has a positive average monthly return. It means that winner portfolios have higher average returns than loser portfolios. However, the WML also has the highest risk as measure by a standard deviation of returns. This result is similar to results from previous studies (Fama & French, 2012).

BAB has a positive average monthly return. Moreover, it delivers a positive Sharpe ratio about as high as the market. The result is similar to Frazzini and Pederson (2014).

Table 4.7: Market risk premium and average returns of SMB, HML, WML and BAB

(Unit percent per month)

	Market	SMB	HML	WML	BAB
Average	1.13	-0.64	-2.79	0.62	0.78
Median	1.62	-0.81	-2.44	-0.10	0.93
SD	6.88	5.23	5.12	7.42	5.03
Sharpe Ratio	0.57	-0.43	-1.88	0.29	0.54
Min	-30.49	-27.90	-23.07	-19.99	-13.83
Max	19.43	17.52	12.24	43.61	15.59

Table 4.8 reports the correlation of monthly return of factor portfolios. It reveals that WML and BAB have negative correlations with MKT, while the SMB and HML have positive correlations with MKT. It also shows that factor portfolios have low correlation with each other except the correlation between the MKT and BAB (-0.55).

Table 4.8: Correlation matrix of monthly returns of factor portfolios

	MKT	SMB	HML	WML	BAB
MKT	1				
SMB	0.04	1			
HML	0.06	0.04	1		
WML	-0.07	-0.19	-0.41	1	
BAB	-0.55	-0.32	-0.26	0.32	1

4.1.2 Testing Beta-sorted portfolio

Table 4.9 presents average monthly excess returns of each testing Beta-sorted portfolio. Port3 has the highest average monthly excess return (2.01%), this portfolio consists of the securities which beta is around 0.70 – 1.10. We find that high beta portfolio (high volatility) earn relatively lower returns. Moreover, high beta portfolio has lower Sharp ratios than low beta portfolio. These findings are consistent with the Frazzini and Pederson (2014) model, in which many investors do not have access to leverage and therefore overweight the high-beta assets to achieve their target return.

Table 4.9: Average monthly excess return of testing Beta-sorted portfolio
(Unit: percent per month)

	(Low beta)				(High beta)	
	P1	P2	P3	P4	P5	BAB
Average	1.76	1.81	2.01	0.87	1.10	0.78
Median	1.28	1.34	1.64	1.84	1.28	0.93
SD	6.75	8.20	8.99	9.31	10.80	5.03
Sharpe Ratio	0.90	0.77	0.77	0.32	0.35	0.54
Min	-31.08	-32.33	-38.55	-38.33	-40.22	-13.83
Max	22.37	25.07	28.22	35.19	30.89	15.59

Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Market risk premium, Fama and French (1993) mimicking portfolios and Carhart (1997) momentum factor. Volatilities and Sharpe ratios are annualized.

Table 4.10 shows that volatility declines as we move from low beta portfolios to high beta portfolios. We find that the alphas decline almost monotonically from the low beta to high beta portfolios. Indeed, the alphas decline when estimated relative to a one-, three- and four-factor model. Moreover, Sharpe ratios decline monotonically from low beta to high beta portfolios. The results are similar to those in Frazzini and Pederson (2014).

The rightmost column of table 4.10 reports returns of the betting-against-beta (BAB) portfolio. The BAB factor delivers a high average return and a high alpha. Specifically, the BAB factor has Sharpe (1964) abnormal returns of 1.24% per month (t-statistic = 3.03). Further adjusting returns for Fama and French (1993), the BAB portfolio earns abnormal returns of 0.56% per month (t-statistic = 1.33). Last, we adjust returns using a four factor model by adding the momentum-factor by Carhart (1997), yielding an abnormal BAB return of 0.64% per month (t-statistic = 1.55).

According to the result, The BAB alpha is insignificant. It means that the returns on the BAB factor do not subsume the effects from market, size, value and momentum factors.

Table 4.10: Monthly alphas for various volatility declines of testing Beta-sorted portfolio

	P1 (Low Beta)		P2		P3		P4	P5 (High Beta)	BAB	
Excess return	**1.76**	***	**1.81**	**	**2.01**	**	**0.87**	**1.10**	**0.78**	
	(2.71)		(2.30)		(2.32)		(0.97)	(1.05)	(1.61)	
CAPM alpha	**0.82**	**	**0.64**		**0.72**	*	**-0.47**	**-0.43**	**1.24**	***
	(2.39)		(1.64)		(1.68)		(-1.09)	(-0.82)	(3.03)	
Three-factor alpha	**0.90**	**	**0.92**	**	**0.81**	**	**0.59**	**0.35**	**0.56**	
	(2.43)		(2.36)		(1.99)		(1.48)	(0.74)	(1.33)	
Four-factor alpha	**0.97**	***	**0.92**	**	**0.85**	**	**0.52**	**0.30**	**0.64**	
	(2.65)		(2.36)		(2.09)		(1.31)	(0.63)	(1.55)	
Volatility	23.39		28.42		31.16		32.25	37.40	17.44	
Sharpe ratio	0.90		0.77		0.77		0.32	0.35	0.54	

*, **, *** show significant at 10%, 5% and 1% levels respectively. t-stat reported in brackets.

The monthly excess return correlations of the testing beta-sorted portfolio shown in Table 4.11 reveal that all testing beta-sorted portfolios have positive correlation with each other but BAB portfolio has negative correlations with the testing beta-sorted portfolios.

Table 4.11: Correlation matrix of excess returns of the testing Beta-sorted portfolio

	P1	P2	P3	P4	P5	BAB
P1	1					
P2	0.84	1				
P3	0.84	0.92	1			
P4	0.83	0.90	0.89	1		
P5	0.83	0.87	0.91	0.92	1	
BAB	-0.36	-0.50	-0.60	-0.70	-0.80	1

4.1.3 Testing portfolio

Table 4.12 presents average monthly excess returns of each testing portfolio. The TNL portfolio has the highest average monthly excess return (3.69%), where the TSH portfolio has the lowest (0.71%). Moreover, the average monthly excess returns vary widely among testing portfolios.

The monthly excess return correlations of the testing portfolio shown in Table 4.13 reveal that all testing portfolios have positive correlation with each other.

Table 4.12: Average monthly excess return of testing portfolios
(Unit: percent per month except Sharpe ratio which has no unit)

	TBH	TBM	TBL	TNH	TNM	TNL	TSH	TSM	TSL
Average	0.99	1.82	3.37	0.96	1.65	3.69	0.71	0.94	3.68
Median	1.38	2.59	3.51	0.83	1.11	3.80	-0.05	0.58	2.26
SD	8.72	7.83	9.59	8.84	8.54	9.60	11.40	10.40	14.52
Sharpe Ratio	0.39	0.81	1.22	0.37	0.67	1.33	0.22	0.31	0.88
Min	-39.13	-30.69	-26.47	-37.59	-34.78	-25.27	-34.19	-37.28	-40.16
Max	25.32	29.90	48.28	28.10	26.48	34.65	53.90	31.12	79.60

Table 4.13: Correlation matrix of excess returns of the testing portfolios

	TBH	TBM	TBL	TNH	TNM	TNL	TSH	TSM	TSL
TBH	1								
TBM	0.87	1							
TBL	0.69	0.78	1						
TNH	0.81	0.80	0.65	1					
TNM	0.81	0.82	0.70	0.88	1				
TNL	0.70	0.73	0.73	0.72	0.77	1			
TSH	0.63	0.73	0.51	0.72	0.69	0.62	1		
TSM	0.71	0.74	0.64	0.82	0.80	0.77	0.78	1	
TSL	0.41	0.42	0.42	0.50	0.56	0.58	0.52	0.63	1

CHAPTER V
EMPIRICAL RESULTS

Table 5.1 presents the regression results of CAPM, Fama-French three-factor model, Carhart four-factor model and BAB augmented 4-factor model. From these results, we find that market monthly excess return coefficient (β) of all testing portfolio is significantly positive at one percent significant level. In addition, average of β of every model is close to 1.0 (Average of β = 1.08), which is consistent to Fama and French (1993).

Average adjusted-R^2 of CAPM model is 65% which means CAPM model can approximately explain half of the expected return. When adding factors to form Fama-French three-factor model and Carhart four-factor model, we find that average adjusted-R^2 both of the models increase to 78%. This means that adding these factors to traditional CAPM can increase the explanatory power to the model.

The SMB coefficients (s) of all models are positively significant at one percent significant level except those existed in the big stock portfolios (TBH, TBM and TBL) which have a significant negative sign. Additionally, the results show that in every model, SMB coefficients will increase from big stock portfolio to small stock portfolio. Thus, we can interpret that returns of small stock portfolios are more sensitive to the size factor (SMB) than big stock portfolios.

Almost all HML coefficients (h) of all models in every portfolio are significant at one percent significant level. Moreover, the Value stock portfolios (TBH, TNH and TSH) consist of HML coefficients which are positive while Growth stock portfolio (TBL, TNL and TSL) contains HML coefficients which are negative.

The results also revealed that WML coefficients (w) are rarely significant, which imply that the momentum factor might not be an important risk factor in the Thai stock market.

Lastly, the regression result of BAB augmented 4-factor model. The result shows that adding the beta factor to the model can increase the average adjusted-R^2 to

79%. This means that adding beta factor to the Carhart four-factor model can increase a little explanatory power to the model. The results also show that BAB coefficients (b) are significant only one out of nine portfolios (TSH) at five percent significant level. In conclusion, beta factor might not be important factor in Thai stock market.

Table 5.1: Time-series regressions of CAPM, Fama-French three-factor, Carhart four-factor model and BAB augmented 4-factor model

	CAPM								Fama Fench									
	α		β		$Ad.R^2$	F		α		β		SMB		HML		$Ad.R^2$	F	
TBH	-0.23		1.09	***	0.73	295.17	***	0.79	*	1.08	***	-0.18	**	0.42	***	0.80	144.83	***
	(-0.53)		(17.18)					(1.85)		(19.64)		(-2.56)		(5.73)				
TBM	0.65	**	1.04	***	0.83	540.67	***	1.07	***	1.04	***	-0.16	***	0.19	***	0.86	214.09	***
	(2.10)		(23.25)					(3.28)		(24.85)		(-2.84)		(3.32)				
TBL	2.04	***	1.18	***	0.72	274.41	***	0.27		1.22	***	-0.42	***	-0.60	***	0.88	255.91	***
	(4.11)		(16.57)					(0.72)		(25.79)		(-6.72)		(-9.40)				
TNH	-0.27		1.09	***	0.72	275.80	***	1.05	***	1.06	***	0.38	***	0.44	***	0.84	182.57	***
	(-0.60)		(16.61)					(2.67)		(21.09)		(5.71)		(6.42)				
TNM	0.43		1.08	***	0.76	335.25	***	0.90	**	1.07	***	0.35	***	0.12		0.81	149.55	***
	(1.05)		(18.31)					(2.19)		(20.17)		(5.03)		(1.64)				
TNL	2.42	***	1.12	***	0.64	193.03	***	1.43	***	1.13	***	0.36	***	-0.44	***	0.73	96.05	***
	(4.33)		(13.89)					(2.61)		(15.99)		(3.85)		(-4.65)				
TSH	-0.64		1.20	***	0.52	115.87	***	0.95		1.16	***	0.83	***	0.46	***	0.71	87.66	***
	(-0.83)		(10.76)					(1.41)		(13.33)		(7.32)		(3.91)				
TSM	-0.43		1.21	***	0.64	191.89	***	-0.06		1.19	***	0.86	***	-0.02		0.83	171.54	***
	(-0.70)		(13.85)					(-0.12)		(19.54)		(10.77)		(-0.19)				
TSL	2.49	**	1.06	***	0.24	35.69	***	0.66		1.06	***	1.35	***	-0.94	***	0.57	48.91	***
	(2.02)		(5.97)					(0.63)		(7.94)		(7.70)		(-5.23)				
$Avg.Ad.R^2$	0.72		1.12		0.65	250.86		0.78		1.11		0.38		-0.04		0.78	150.12	

*, **, *** show significant at 10%, 5% and 1% levels respectively. t-stat reported in brackets.

Table 5.1: Time-series regressions of CAPM, Fama-French three-factor, Carhart four-factor model and BAB augmented 4-factor model (Cont.)

	4- Factors							5- Factors							
	α	β	SMB	HML	WML	Ad.R²	F	α	β	SMB	HML	WML	BAB	Ad.R²	F
TBH	0.77 *	1.07 ***	-0.19 **	0.41 ***	-0.02	0.80	107.82 ***	0.77 *	1.07 ***	-0.19 **	0.41 ***	-0.02	0.00	0.80	85.42 ***
	(1.79)	(19.52)	(-2.59)	(5.05)	(-0.43)			(1.77)	(15.77)	(-2.44)	(4.94)	(-0.42)	(-0.01)		
TBM	1.01 ***	1.03 ***	-0.17 ***	0.14 **	-0.08 *	0.86	164.87 ***	1.09 ***	0.99 ***	-0.20 ***	0.12 **	-0.06	-0.12	0.86	134.19 ***
	(3.13)	(24.99)	(-3.15)	(2.34)	(-1.81)			(3.35)	(19.53)	(-3.51)	(2.04)	(-1.46)	(-1.55)		
TBL	0.35	1.23 ***	-0.39 ***	-0.53 ***	0.12 **	0.88	203.10 ***	0.32	1.24 ***	-0.38 ***	-0.52 ***	0.11 **	0.04	0.88	161.30 ***
	(0.97)	(26.52)	(-6.30)	(-7.80)	(2.49)			(0.89)	(21.73)	(-5.79)	(-7.56)	(2.33)	(0.48)		
TNH	1.03 ***	1.06 ***	0.37 ***	0.42 ***	-0.02	0.83	135.87 ***	1.12 ***	1.01 ***	0.34 ***	0.40 ***	-0.01	-0.13	0.84	109.98 ***
	(2.61)	(20.96)	(5.51)	(5.68)	(-0.41)			(2.80)	(16.29)	(4.80)	(5.36)	(-0.13)	(-1.36)		
TNM	0.91 **	1.07 ***	0.35 ***	0.13	0.02	0.80	111.21 ***	1.00 **	1.02 ***	0.32 ***	0.11	0.03	-0.13	0.81	89.96 ***
	(2.20)	(20.07)	(4.98)	(1.62)	(0.31)			(2.38)	(15.59)	(4.31)	(1.36)	(0.57)	(-1.32)		
TNL	1.40 **	1.13 ***	0.35 ***	-0.46 ***	-0.04	0.73	71.63 ***	1.42 **	1.12 ***	0.34 ***	-0.47 ***	-0.04	-0.02	0.72	56.77 ***
	(2.54)	(15.89)	(3.67)	(-4.46)	(-0.55)			(2.52)	(12.74)	(3.40)	(-4.39)	(-0.50)	(-0.18)		
TSH	0.99	1.16 ***	0.84 ***	0.48 ***	0.05	0.71	65.35 ***	0.74	1.31 ***	0.94 ***	0.54 ***	0.00	0.39 **	0.72	56.07 ***
	(1.45)	(13.29)	(7.26)	(3.78)	(0.53)			(1.10)	(12.50)	(7.84)	(4.25)	(0.03)	(2.46)		
TSM	0.01	1.19 ***	0.88 ***	0.04	0.09	0.83	130.62 ***	0.09	1.15 ***	0.85 ***	0.02	0.11 *	-0.12	0.83	104.94 ***
	(0.01)	(19.69)	(10.92)	(0.42)	(1.47)			(0.18)	(15.37)	(10.00)	(0.21)	(1.66)	(-1.10)		
TSL	0.53	1.05 ***	1.31 ***	-1.04 ***	-0.18	0.58	37.36 ***	0.72	0.94 ***	1.24 ***	-1.09 ***	-0.14	-0.30	0.58	30.32 ***
	(0.51)	(7.89)	(7.35)	(-5.33)	(-1.31)			(0.69)	(5.71)	(6.59)	(-5.48)	(-1.03)	(-1.22)		
Avg.Ad.R²	0.78	1.11	0.37	-0.05	-0.01	0.78	114.20	0.81	1.09	0.36	-0.05	0.00	-0.04	0.79	92.11

*, **, *** show significant at 10%, 5% and 1% levels respectively. t-stat reported in brackets.

Table 5.2 shows t-statistics of intercept coefficients (Alpha, α) of every portfolio in all models. We can notice that the alphas of five out of nine portfolios in the BAB augmented 4-factor models are significantly different from zeros (TBH, TBM, TNH, TNM and TNL). In addition, the number of significant intercepts is increased from the CAPM to Five-factor model.

Table 5.2: t-Statistic of alphas of CAPM, Fama-French three-factor, Carhart four-factor and BAB augmented 4-factor models.

	CAPM		Fama-French		4-Factors		5-Factors	
TBH	-0.53		1.85	*	1.79	*	1.77	*
TBM	2.10	**	3.28	***	3.13	***	3.35	***
TBL	4.11	***	0.72		0.97		0.89	
TNH	-0.60		2.67	***	2.61	***	2.80	***
TNM	1.05		2.19	**	2.20	**	2.38	**
TNL	4.33	***	2.61	***	2.54	**	2.52	**
TSH	-0.83		1.41		1.45		1.10	
TSM	-0.70		-0.12		0.01		0.18	
TSL	2.02	**	0.63		0.51		0.69	

*, **, *** show significant at 10%, 5% and 1% levels respectively. t-stat reported in brackets.

Table 5.3 reports Gibbons-Ross-Shanken (GRS) F statistic. The GRS statistic tests the null hypothesis that all the pricing errors (intercepts, α) are jointly equal to zero. If an asset pricing model is empirically valid, we will not be able to reject the null hypothesis. Table 12 presents both the GRS F stats and their p-values of all models. The results in Table 12 reveals that p-values of all models are significant at five percent significant level except CAPM which is significant at one percent significant level, which means the null hypothesis is rejected, the intercepts are not jointly equal to zero. According to the test, the evidence of significant intercepts suggests that there remain unexplained variables in the BAB augmented 4-factor model.

Table 5.3: Gibbons-Ross-Shanken (GRS) statistic

Stat	CAPM		Fama French		Carhart		BAB augmented 4 - factor	
GRS F	4.55		2.41		2.27		2.34	
P-Value	0.00	***	0.02	**	0.02	**	0.02	**

*, **, *** show significant at 10%, 5% and 1% levels respectively. t-stat reported in brackets.

CHAPTER VI
CONCLUSION

In this study, we examined the importance of beta factor in pricing stock returns in Thai stock market. The five factors include the market factor (market risk premium, MKT), the size factor (small market capitalization minus big market capitalization, SMB), the book-to-market factor (high book-to-market equity ratio minus low book-to-market equity ratio, HML), the momentum factor (winners minus losers, WML) and beta factor (BAB). Our data cover stocks traded in the Stock Exchange of Thailand (SET100) from February 2003 to February 2012. Monthly excess stock returns are computed from nine testing portfolios based on size and book-to-market ratios. Time series regressions following Fama and French (1992) are employed to test the five-factor model on these nine testing portfolios.

The result shows that adding the beta factor to the model can increase the average adjusted-R^2 and the number of significant intercepts is reduced. The BAB augmented 4-factor model has more explanatory power than the traditional CAPM model, Fama-French three-factor model and Carhart four-factor model. The regression results suggest that beta factor might not be an important factor in asset pricing models.

Moreover, we examine the return dynamics of the high-beta and the low-beta stocks (Betting against beta portfolio) in the Thai stock market. Monthly excess stock returns are computed from two portfolios which are long leveraged low beta stocks and short-sells de-leveraged high beta stocks.

We find that Betting against beta portfolio earns significant positive returns and the returns of this factor do not dominate the size, value, and momentum factors returns in Thailand. The portfolios of high beta asset have lower alphas and Sharpe ratios than portfolios of low beta asset.

We consider more conservative method by using Return on investment (ROI) to calculate the return of portfolios instead of percentage of change. As a result, the return of portfolios which is calculated by ROI can better reflect the return in reality. Because ROI includes price movements (capital gain/loss), rights offered to current shareholders allowing them to purchase additional shares, usually at a discount to market price (rights offering), and income from dividend payments (dividends) assuming the invertor are reinvested in securities.

Furthermore, we run the BAB augmented 4-factor regression model to examine the relationship between BAB and sample mutual fund returns to investigate whether asset management companies use BAB as one of the risk factor in their portfolio construction. The results convince us to hypothesize that local (Thai) asset management companies might not consider BAB whereas international asset management companies consider BAB as an important risk factor in their portfolio construction.

The limitation of this study is that we only study stocks in the SET100 index. In the future study, researchers can go beyond the first hundred to cover most stocks listed in the Stock Exchange of Thailand (SET) or to cover other asset classes.

REFERENCES

Agarwalla, S. K., Jacob, J., Varma, J. R., & Vasudevan, E. (2014). *Betting Against Beta in the Indian Market*. Working Paper. Finance. Indian Institute of Management, Ahmedabad. India.

Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of business*, *45*(3), 444-455.

Black, F. (1993). Beta and return *Journal of Portfolio Management.*, *20*(1), 8-18.

Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. *Journal of Finance*, *52*(1), 57-82

Cochrane, J. H. (2005). *Asset Pricing (Revised Edition ed.)*.

Davivongs, K., & Pavabutr, P. (2012). Pricing of Liquidity Risk in Emerging Markets: Evidence from Greater China. *International Review of Business Research Papers*, *8*(1), 20-32.

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *the Journal of Finance, 47*(2), 427-465.

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. (1996). Multifactor Explanations of Asset Pricing Anomalies. *Journal of Finance, 51*(1), 55-84.

Fama, E. F., & French, K. R. (2012). Size, value, and momentum in international stock returns. *Journal of Financial Economics, 105*(3), 457-472.

Frazzini, A., & Pederson, L. H. (2014). Betting Against Beta. *Journal of Financial Economics, 111*(1), 1-25.

Gibbons, M. R., Ross, S. A., & Shanken, J. (1989). A Test of the Efficiency of a Given Portfolio. *Journal of Finance, 57*(5), 1121-1152.

Pongsuwan, P., Uphaiprom, K., & Chantabal, P. (2014). *Five-Factor Asset Pricing Model: Evidence from Thai Stock Market.* (Master of Management), Mahidol University, Bangkok, Thailand.

Ruzhe, N. (2004). *Test of the Fama-French model in the stock exchange of Thailand.* (Master of Economics), Chulalongkorn University, Bangkok, Thailand.

Sharpe, W. F. (1964). Capital Asset Prices: a Theory of Market Equilibrium Under Conditions of Risk. *Journal of Finance, 19*(3), 425-442.

APPENDICES

Appendix A

Average monthly excess return and standard deviation of monthly excess return in various regions (Fama & French, 2012)

Global Monthly Excess Return (%)

	B1	B2	M	S1	S2
H1	0.53	0.69	0.74	0.79	1.12
H2	0.53	0.60	0.57	0.69	0.83
M	0.49	0.52	0.52	0.59	0.77
L1	0.36	0.43	0.40	0.46	0.48
L2	0.29	0.37	0.21	0.09	0.07

Global Monthly Std. dev (%)

	B1	B2	M	S1	S2
H1	5.40	4.78	4.65	4.56	4.38
H2	4.45	4.47	4.47	4.40	4.64
M	4.41	4.50	4.64	4.68	5.09
L1	4.29	4.61	5.19	5.21	5.48
L2	4.62	5.66	5.78	5.87	5.94

North America Monthly Excess Return (%)

	B1	B2	M	S1	S2
H1	0.64	0.96	1.08	1.08	1.42
H2	0.66	0.84	0.86	0.94	1.04
M	0.62	0.89	0.87	0.95	1.13
L1	0.56	0.73	0.70	0.73	0.75
L2	0.54	0.80	0.90	0.34	0.50

North America Monthly Std. dev (%)

	B1	B2	M	S1	S2
H1	5.48	4.79	5.03	5.24	5.43
H2	4.35	4.75	4.67	4.90	5.50
M	4.32	4.76	5.14	5.73	6.42
L1	4.35	5.29	6.02	6.82	7.15
L2	4.84	6.97	7.34	7.77	8.48

Europe Monthly Excess Return (%)

	B1	B2	M	S1	S2
H1	0.73	0.88	0.86	0.89	0.88
H2	0.76	0.64	0.62	0.78	0.66
M	0.65	0.66	0.62	0.53	0.44
L1	0.52	0.57	0.54	0.42	0.29
L2	0.31	0.39	0.21	0.10	-0.13

Europe Monthly Std. dev (%)

	B1	B2	M	S1	S2
H1	6.44	5.81	5.47	5.26	4.89
H2	5.56	5.29	5.30	5.14	4.94
M	5.16	5.10	5.10	5.15	5.21
L1	4.83	4.90	5.32	5.40	5.50
L2	5.09	5.57	6.01	6.13	5.79

Japan Monthly Excess Return (%)

	B1	B2	M	S1	S2
H1	0.35	0.05	0.12	0.03	0.22
H2	0.18	0	-0.16	0.01	0.08
M	-0.1	-0.21	-0.27	-0.13	0.02
L1	-0.1	-0.18	-0.39	-0.37	-0.08
L2	-0.33	-0.5	-0.42	-0.45	-0.17

Japan Monthly Std. dev (%)

	B1	B2	M	S1	S2
H1	7.44	6.84	6.97	7.23	7.25
H2	6.02	6.05	6.46	7.08	7.31
M	6.15	6.06	6.72	7.17	7.58
L1	5.99	6.44	7.06	7.78	7.81
L2	6.95	7.51	7.93	8.30	9.32

Asia Pacific Monthly Excess Return (%)

	B1	B2	M	S1	S2
H1	1.13	1.16	0.92	1.06	1.61
H2	0.94	1.08	1.00	0.79	1.17
M	0.95	0.66	0.88	0.63	0.87
L1	0.97	0.96	0.77	0.51	0.61
L2	0.69	0.90	0.10	0.17	0.39

Asia Pacific Monthly Std. dev (%)

	B1	B2	M	S1	S2
H1	8.11	8.49	8.04	7.94	7.41
H2	6.90	6.95	7.04	7.23	7.34
M	6.45	6.35	6.76	6.91	7.36
L1	6.25	6.20	6.88	7.72	8.03
L2	6.52	6.67	7.37	7.21	8.18

Note:

B1 represents the securities group in the first 20th percentile which has the big size of market capitalization.

B2 represents the securities group in the 20th percentile which has the big size of market capitalization.

M represents the securities group which has the medium size of market capitalization.

S1 represents the securities group in the first 20th which has the small size of market capitalization.

S2 represents the securities group in the 20th percentile which has the small size of market capitalization.

H1 represents the securities group in the first 20th which has the high value of book-to-market ratio.

H2 represents the securities group in the 20th percentile which has the high value of book-to-market ratio.

M represents the securities group which has the medium value of book-to-market ratio.

L1 represents the securities group in the first 20th which has the low value of book-to-market ratio.

L2 represents the securities group in the 20th percentile which has the low value of book-to-market ratio.

Appendix B

Average monthly excess return, standard deviation of monthly excess return and Sharpe Ratio of monthly excess return in the Stock Exchange of Thailand (SET) (Pongsuwan et al., 2014)

Average monthly excess return (%)

Portfolio	B	S	Avg
H	0.96	0.40	0.68
M	1.50	0.35	0.93
L	2.90	2.54	2.72
Avg	1.79	1.10	

Standard deviation of monthly excess return (%)

Portfolio	B	S	Avg
H	6.87	8.74	7.81
M	6.45	8.49	7.47
L	8.48	9.98	9.23
Avg	7.27	9.07	

Sharpe Ratio of monthly excess return (%)

Portfolio	B	S	Avg
H	0.14	0.05	0.10
M	0.23	0.04	0.14
L	0.34	0.25	0.30
Avg	0.24	0.11	

Average monthly excess return, standard deviation and Sharpe ratio of Winner and Loser portfolio (%)

	W	L	Market
Average excess return	1.75	0.89	1.20
Standard deviation	7.94	7.60	5.70
Sharpe ratio	0.22	0.12	0.21

Appendix C

Average monthly excess return and standard deviation of monthly excess return in China and Taiwan (Davivongs & Pavabutr, 2012)

Average monthly excess return (%)

	B1	B2	M	S1	S2
China	2.44	2.42	1.75	2.37	1.09
Taiwan	0.62	0.23	-1.17	-2.24	-2.26

Appendix D

Average monthly excess return, standard deviation and Sharpe ratio of monthly excess return in US Equities (Frazzini & Pederson, 2014)

Portfolio	P1 (low beta)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (high beta)	BAB
Excess return	**0.91**	**0.98**	**1.00**	**1.03**	**1.05**	**1.10**	**1.05**	**1.08**	**1.06**	**0.97**	**0.70**
	(6.37)	(5.73)	(5.16)	(4.88)	(4.49)	(4.37)	(3.84)	(3.74)	(3.27)	(2.55)	(7.12)
CAPM alpha	**0.52**	**0.48**	**0.42**	**0.39**	**0.34**	**0.34**	0.22	0.21	0.10	−0.10	**0.73**
	(6.30)	(5.99)	(4.91)	(4.43)	(3.51)	(3.20)	(1.94)	(1.72)	(0.67)	(−0.48)	(7.44)
Three-factor alpha	**0.40**	**0.35**	**0.26**	**0.21**	**0.13**	0.11	−0.03	−0.06	**−0.22**	**−0.49**	**0.73**
	(6.25)	(5.95)	(4.76)	(4.13)	(2.49)	(1.94)	(−0.59)	(−1.02)	(−2.81)	(−3.68)	(7.39)
Four-factor alpha	**0.40**	**0.37**	**0.30**	**0.25**	**0.18**	**0.20**	0.09	0.11	0.01	−0.13	**0.55**
	(6.05)	(6.13)	(5.36)	(4.92)	(3.27)	(3.63)	(1.63)	(1.94)	(0.12)	(−1.01)	(5.59)
Five-factor alpha	**0.37**	**0.37**	**0.33**	**0.30**	**0.17**	**0.20**	0.11	0.14	0.02	0.00	**0.55**
	(4.54)	(4.66)	(4.50)	(4.40)	(2.44)	(2.71)	(1.40)	(1.65)	(0.21)	(−0.01)	(4.09)
Beta (ex ante)	0.64	0.79	0.88	0.97	1.05	1.12	1.21	1.31	1.44	1.70	0.00
Beta (realized)	0.67	0.87	1.00	1.10	1.22	1.32	1.42	1.51	1.66	1.85	−0.06
Volatility	15.70	18.70	21.11	23.10	25.56	27.58	29.81	31.58	35.52	41.68	10.75
Sharpe ratio	0.70	0.63	0.57	0.54	0.49	0.48	0.42	0.41	0.36	0.28	0.78

Appendix E

Average monthly excess return, standard deviation and Sharpe ratio of monthly excess return in International Equities (Frazzini & Pederson, 2014)

Portfolio	P1 (low beta)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (high beta)	BAB
Excess return	**0.63**	**0.67**	**0.69**	**0.58**	**0.67**	0.63	0.54	0.59	0.44	0.30	**0.64**
	(2.48)	(2.44)	(2.39)	(1.96)	(2.19)	(1.93)	(1.57)	(1.58)	(1.10)	(0.66)	(4.66)
CAPM alpha	**0.45**	**0.47**	**0.48**	**0.36**	**0.44**	**0.39**	0.28	0.32	0.15	0.00	**0.64**
	(2.91)	(3.03)	(2.96)	(2.38)	(2.86)	(2.26)	(1.60)	(1.55)	(0.67)	(−0.01)	(4.68)
Three-factor alpha	**0.28**	**0.30**	**0.29**	0.16	0.22	0.11	0.01	−0.03	−0.23	−0.50	**0.65**
	(2.19)	(2.22)	(2.15)	(1.29)	(1.71)	(0.78)	(0.06)	(−0.17)	(−1.20)	(−1.94)	(4.81)
Four-factor alpha	0.20	0.24	0.20	0.10	0.19	0.08	0.04	0.06	−0.16	−0.16	**0.30**
	(1.42)	(1.64)	(1.39)	(0.74)	(1.36)	(0.53)	(0.27)	(0.35)	(−0.79)	(−0.59)	(2.20)
Five-factor alpha	0.19	0.23	0.19	0.09	0.20	0.07	0.05	0.05	−0.19	−0.18	**0.28**
	(1.38)	(1.59)	(1.30)	(0.65)	(1.40)	(0.42)	(0.33)	(0.30)	(−0.92)	(−0.65)	(2.09)
Beta (ex ante)	0.61	0.70	0.77	0.83	0.88	0.93	0.99	1.06	1.15	1.35	0.00
Beta (realized)	0.66	0.75	0.78	0.85	0.87	0.92	0.98	1.03	1.09	1.16	−0.02
Volatility	14.97	16.27	17.04	17.57	18.08	19.42	20.42	22.05	23.91	27.12	8.07
Sharpe ratio	0.50	0.50	0.48	0.40	0.44	0.39	0.32	0.32	0.22	0.13	0.95

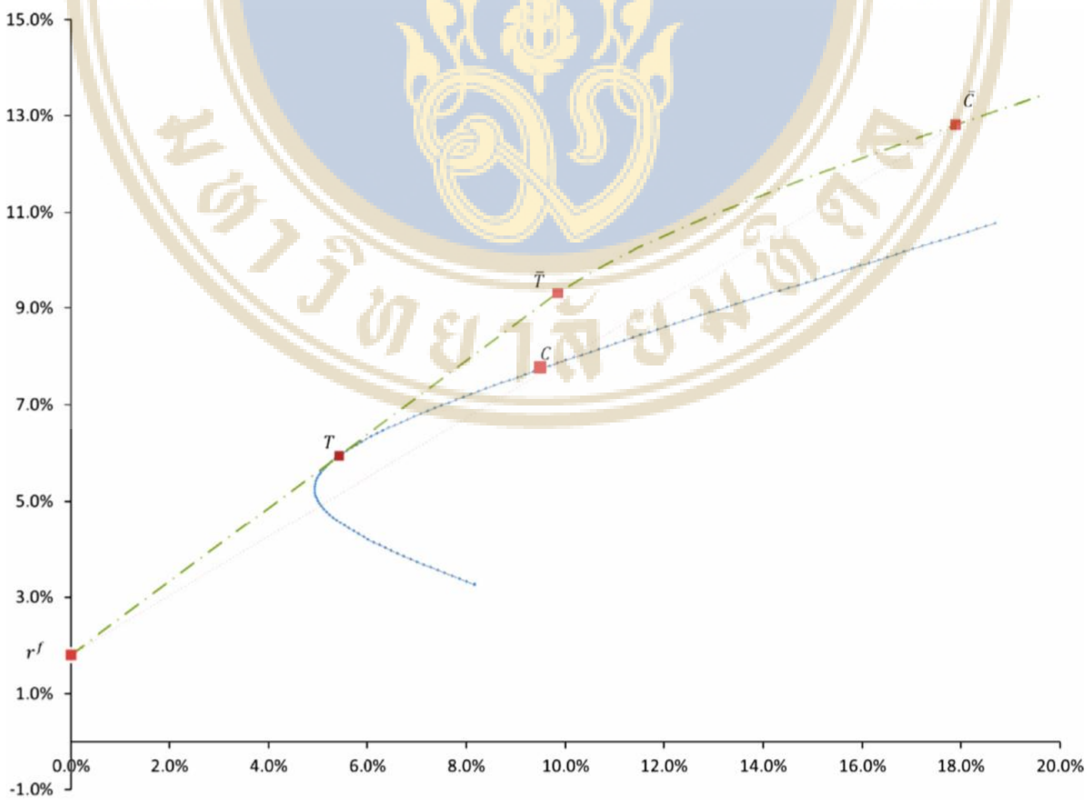
Appendix F

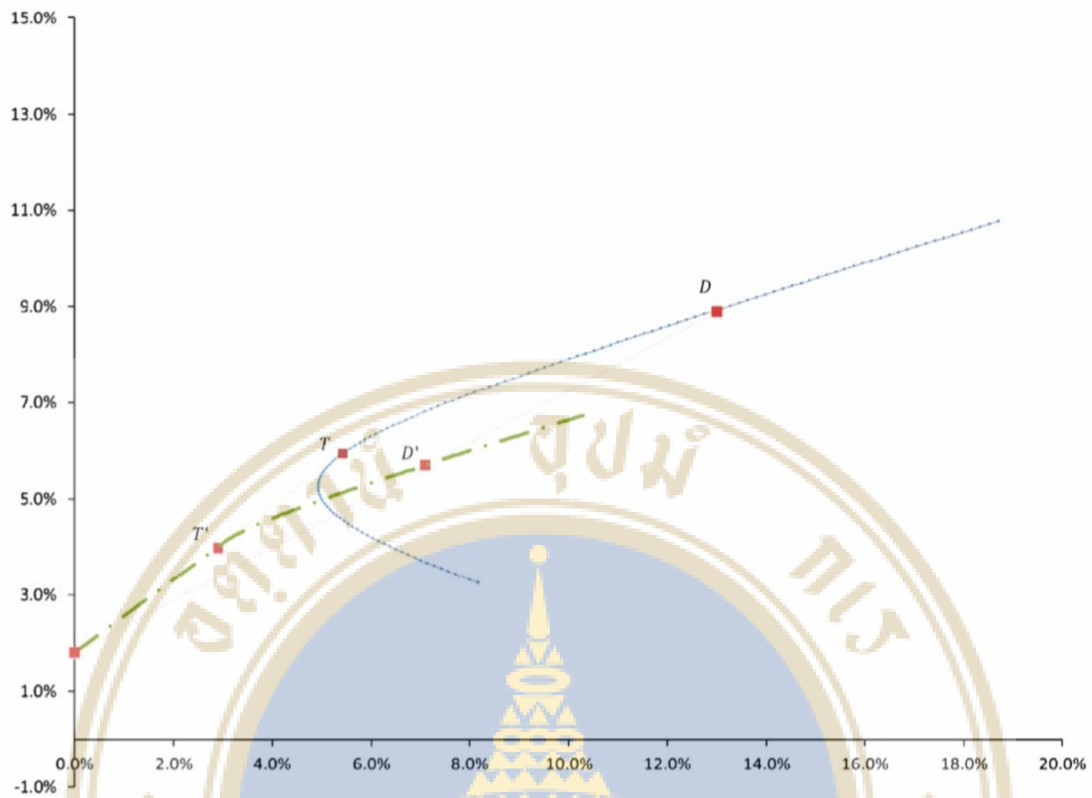
Average monthly excess return, standard deviation and Sharpe ratio of monthly excess return in India Equities (Agarwalla et al. (2014))

Porfolio	P1 (Low-beta)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (High-beta)	BAB
Panel A: Equally weighted portfolios											
XR (over R_F)	0.01	0.26	0.22	0.23	-0.05	0.17	-0.20	-0.79	-1.21	-1.97	1.70***
CAPM alpha	-0.44	-0.29	-0.39	-0.42	-0.72*	-0.54	-0.96**	-1.58***	-2.04***	-2.89***	1.67***
Three-factor alpha	-0.99***	-0.79***	-0.89***	-0.92***	-1.20***	-1.10***	-1.50***	-2.16***	-2.68***	-3.61***	1.35***
Four-factor alpha	-0.97***	-0.67**	-0.79***	-0.73***	-1.00***	-0.89***	-1.25***	-1.78***	-2.32***	-3.09***	1.08**
Beta (ex-ante)	0.56	0.68	0.75	0.81	0.86	0.91	0.97	1.05	1.15	1.38	0.00
Beta (realized)	0.70	0.86	0.96	1.01	1.05	1.12	1.18	1.24	1.31	1.44	0.09
Volatility	31.43	33.37	34.37	35.70	36.32	38.94	40.88	43.51	47.20	54.71	23.79
Sharpe ratio	0.00	0.09	0.08	0.08	-0.02	0.05	-0.06	-0.22	-0.31	-0.43	0.86

Portfolio selection with constraints

The top panel shows the mean-standard deviation frontier for an agent with mo1 who can use leverage, and the bottom panel shows that of an agent with m41 who needs to hold cash.

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