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Testing The Capital Asset Pricing Model: Empirical Evidences in the Vietnam's Stock Market

Nguyen Thi Thanh Nga*

Abstract

This paper applies the CAPM in examining Vietnam's stock market by the method of Fama and MacBeth. In order to overcome the limitation of data, this empirical analysis modified Fama and MacBeth for verifying the applicability of the CAPM. The analytical results show that the CAPM does not sufficiently valid in Vietnam's stock market. This attempt contributes to the existing literature in laying the foundation for more studies of the fundamental asset pricing model in Vietnam as well as other emerging economies.

Keywords: CAPM, stock return, beta, systematic risk, Fama-MacBeth method

1. Introduction

Vietnam's stock market is younger than other stock markets in the world. Notwithstanding, it has grown quite impressively in recent years. Vietnam's stock market comprises two stock exchanges, viz., the Ho Chi Minh City Stock Exchange (HOSE) and the Hanoi Stock Exchange (HNX). The former was established in 2000, whereas the latter was created five years later. Up to the end of 2017, both stock exchanges have 707 listed companies. The government has indicated it will merge the two stock exchanges in future.[1]

Until now, the HOSE is larger and it also has a higher liquidity than the HNX. Although the HOSE market is only twenty years old, but it has grown impressively. Its market capitalization grew from US$82 million in 2010 to over US$107 million in 2016. In this regard, it is anticipated that Vietnam's stock market will increasingly become a key channel for mobilizing resources in enhancing capital and financial intermediaries in driving economic progress.

For this reason, domestic investors and those from abroad need to deepen their understanding of the relationship between risk and return in Vietnam's stock market. The Capital Asset Pricing Model (CAPM), which was propounded by Sharpe (1964), Lintner (1965), Mossin (1965), is an important analytical tool for clarifying risk and return in Vietnam's stock market. The beta coefficient is a measure of the volatility or systematic risk of a security or portfolio compared to the overall market. Put differently, the beta explains the relationship between systematic risk and expected return for assets. The CAPM is expressed as a linear function of beta and expected return of a security. The CAPM states that for the expected return—E[Ri]—of asset is denoted as follows.

$$E[R_i] = R_f + \beta_i(E[R_M] - R_f), \beta_i = \frac{Covariance(R_i, R_M)}{Variance(R_M)}$$

where R_i is the return on asset i, R_M is the return on the overall market, R_f is the risk-free rate, β_i is called the beta of asset i.

Empirical studies of the CAPM is well documented in the last few decades. It is valuable to highlight the study of Douglas (1969), which tested the CAPM based on individual security returns. His analytical results showed that the CAPM did not support in his data-set. More specifically, his findings show that the risk-free rate of return has a value smaller than the intercept. The intercept is the risk-free rate of return when the expected risk is zero. From an econometric point of view, however, Douglas (1969) is not necessarily correct. Market risk premium is based on the portfolio performance in excess

* Graduate School of Economics and Business Administration, Reitaku University.
1 https://vietnaminsider.vn/prime-minister-agrees-merger-of-hnx-and-hose/ on Sep 20,2019.

to the market excess return and other factors[2]. Risk-free rate of return is zero in efficient market. Otherwise, market is inefficient. Furthermore, the regression model of market risk premium has two errors, viz., α the cross-sectional pricing error, and ϵ the idiosyncratic risk/error.

Black, Jensen, and Scholes (1972), in order maximize the spread in beta across portfolios, tested the effect of beta on return. Their analysis was a time series test of the CAPM. Their analytical results demonstrated that the expected excess return on an asset was not consistent with its beta. Fama and MacBeth (1973) used an another methodology to test the CAPM. They formed 20 portfolios of stocks for the estimation of beta from a time series regression based on the same procedure as in Black, Jensen, and Scholes (1972). However, they conducted an additional analysis, which performed the cross-sectional regression for the monthly data set from 1935 to 1968. The cross-sectional regression for the monthly data set enabled the investigation of how the parameters changed over time. However, contrasting Douglas (1969), their estimated results indicated that, the intercept is larger than the risk-free rate. However, the average return and the beta supported their linear relationship. The linear relationship is even stronger when the data covered a longer period.

Empirical studies and evidences on the relationship between risk and return test are limited in the Southeast Asia capital markets, especially in Vietnam. Therefore, this study aims to analyze the CAPM in Vietnam's stock market. In order to contribute to the accumulation of empirical evidences, this study focuses on the test of risk-return relationship with a broader impact of different portfolios formation and data frequencies, viz, daily and monthly data. More specifically, this study applies the CAPM for the purpose of verifying the hypothesis of higher risk (beta) is associated with a high level of return on the HOSE for the period between January 2010 and April 2018. The analytical method is the same as the Fama-MacBeth procedure. The remainder of this paper is organized as follows. Next section discusses the data and research methodology. Section three presents the analytical results. Section four concludes the paper.

2. Data and Methodology

2.1. Data

This study uses stock returns from listed companies in the HOSE from January 2010 to April 2018. Although the HOSE had its first trading section in July 2000, the sample for the period prior to 2010 has at least two constrains: firstly, initially stock returns had high volatility; secondly, only a few stocks were traded. In addition, listed companies that have shorter than the minimum 24 monthly observations are excluded from the data set because it required the continuity of 100 months. The reason is that the analysis wants to avoid a biased estimation of the relationship between betas and the return on assets. There are 349 listed companies, but those companies that meet the data requirements in this study are 238. It is not easy to obtain official time series data of listed companies from the HOSE. Hence, this study has relied on sources from consulting and advisory financial companies. Individual stock price data, the risk-free return (the Vietnam government 5-year bond) were obtained from the Cophieu68[3]. This study uses the VN-INDEX as a proxy for the market portfolio. This analysis uses R software package.

2.2. Methodology

This study applies the Fama-MacBeth two-step regression method to test the CAPM. The first estimation is a time series regression of the beta for each portfolio p. The model specification is shown below.

$$R_{pt} - R_f = \alpha_i + \beta_p\left(R_{mt} - R_f\right) + \varepsilon_{pt} \qquad (1)$$

R_{pt} and R_{mt} is the return of p-th portfolio and the market portfolio at time t, respectively. R_f is the risk-free rate, and ε_{pt} is the error term.

The second estimation is a cross-sectional regression at each time t:

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_p + \hat{\gamma}_{2t}\hat{\beta}_p^2 + \hat{\gamma}_{3t}S(\hat{\varepsilon}_p) + \hat{\eta}_{pt} \quad (2)$$

$\hat{\beta}_p$ is the beta of p-th portfolio calculated by (1), $\hat{\eta}_p$ is the error term, $S(\hat{\varepsilon}_p)$ is the standard deviation of ε_p in (1).

Thus, given T periods of data in (2), The estimates of $\hat{\gamma}_{0t}$, $\hat{\gamma}_{1t}, \hat{\gamma}_{3t}$ (t = 1,...,T) are obtained. The time series sample mean $\hat{\gamma}_j$ of the estimates $\hat{\gamma}_{jt}$ (j = 0, 1, 2, 3) are used for testing the null hypothesis of $\hat{\gamma}_{jt}$. Fama and MacBeth (1973) have constructed their portfolios shown in (1) as follows. Their portfolios were based on the size like other studies because the size produces a wide spread of the average return and β. However, this method creates a serious econometric problem because portfolios based on the size and the β are highly correlated. The estimated $\hat{\beta}_p$ in this large portfolio will either become higher or lower than the corresponding true β_p.

This shortcoming can be eluded by forming portfolios

[2] $\left(E[R_M] - R_f\right) = \alpha + \beta^*_{abt}\left(R_{abt} - R_f\right) + \sum_{i=1}^{n} x_{b,t} + \varepsilon_t$, Carhart (1997).

[3] URL: https: //www.cophieu68.vn, https://www.investing.com/commodities/gold on Jan 2,2020.

Table 1 Number of stocks in industry portfolios Period 2010-2018

Industry number	Industry name	Total number of companies
1	Material	40
2	Health care	8
3	Energy	9
4	Utilities	14
5	Financial	13
6	Consumer Staples	29
7	Information Techonology	8
8	Real Estate	28
9	Consumer Discretionary	24
10	Industrial	65
	Total	238

Source: Created by author.

Table 2 Estimated results of portfolios for period 2010-2015

Statistic	1	2	3	4	5	6	7	8	9	10	Mean
$\hat{\beta}_{pt}$	0.767	0.418	0.864	0.604	1.064	0.586	0.661	0.921	0.699	0.786	0.737
$S(\hat{\beta}_{pt})$	0.053	0.055	0.064	0.052	0.069	0.047	0.076	0.070	0.052	0.062	0.060
t-value $(\hat{\beta}_{pt})$	7.566	3.993	7.131	6.095	8.059	6.545	4.567	6.866	7.016	6.666	6.450

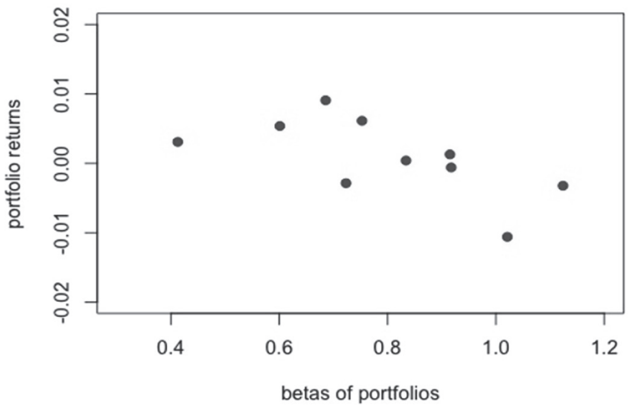
Source: Created by author.

Table 3 Estimated results of the cross-sectional regression

Coefficient	Mean	Std	t-statistic	p-value
$\hat{\gamma}_{0t}$	0.063	0.190	1.758	0.090
$\hat{\gamma}_{1t}$	-0.176	0.451	-2.073	0.047
$\hat{\gamma}_{2t}$	0.108	0.274	2.089	0.045
$\hat{\gamma}_{3t}$	0.312	2.106	0.781	0.439

Source: Created by author.

Figure 1 Portfolio returns versus betas (2010-2018)



Source: Created by author.
Note: The symbol (•) denotes the average monthly return and risk of 10 portfolios.

from ranked $\hat{\beta}_i$ computed from data for one period, but then using a subsequent period to obtain the $\hat{\beta}_p$. These methods are used to test the CAPM. Fama-MacBeth used 42 years monthly data. They divideded them to twenty different portfolio formation period. While 7 years of monthly data are used for constructing portfolio, whereas initial 5-year monthly data are used for a time series regression of (1), and the last 4 years monthly data are used for the cross-ectional regression of equation (2).

For the HOSE, this study obtained only 100 monthly data. Therefore, instead of wholly applying the method of portfolio construction by Fama and MacBeth (1973), this analysis uses the following method: industrial category for making portfolio; the use of individual stock data (not making portfolio); the use of individual stock data (not making portfolio) plus beta adjustment; the use of daily data that follows the method of Fama and MacBeth (1973). These specifications are useful for verifying the validity of the CAPM in the HOSE.

Table 4 Estimated betas of stock returns (from January 2010 to December 2015)

Coefficient	Obs	Mean	Standard error	Min	Max
Beta	238	0.825	0.469	-0.275	2.224

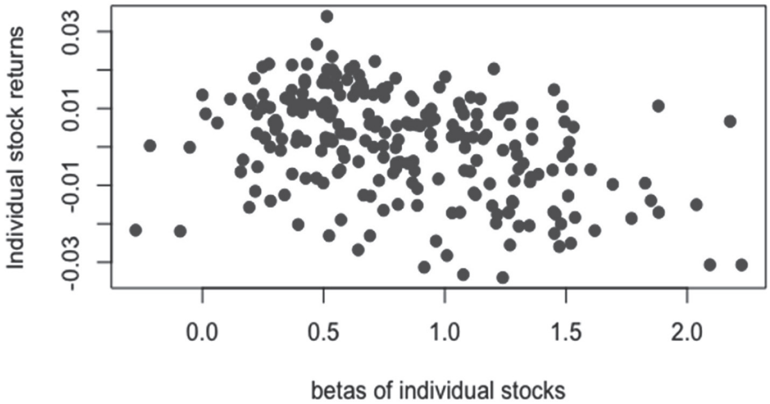
Source: Created by author.

Table 5 Quantiles of betas and their average return

Quantile	Beta	Average return
Minimum	-0.275	-0.021
25%	0.491	-0.001
50%	0.752	0.003
70%	1.155	0.002
Maximum	2.224	-0.030

Source: Created by author.

Figure 2 Individual stock returns versus betas, period: 2010-2018



Source: Created by author.
Note: (•) denotes the average monthly return and risk of each stock (238 stocks).

2.3. Case1: Using industrial category for making portfolio

Because of the limitation in the data set, this study firstly formulates portfolios using industrial category. This formulation assumes that same industrial category gives the same beta. This approach classifies listed companies into 10 major industrial sectors.[4] Table 1 shows these portfolios based on industrial classification.

Based on these portfolios, this study conducted the time-series regression of (1) using 6-year monthly data (from January 2010 to December 2015). Furthermore, it also carried out the cross- sectional regression of (2) using the last 3 years monthly data (from January 2016 to April 2018).

2.4. Case2: Using individual stock data without making portfolio

This approach tested the CAPM without using portfolio. The listed companies are 238.

2.5. Case3: Using individual stock data without making portfolio and beta adjustment

This method calculated adjusted beta from the following equation. $\hat{\beta}_{i(t+1)}$ is adjusted beta, and β_{it} is the beta[5].

$$\hat{\beta}_{i(t+1)} = \frac{1}{3} + \frac{2}{3}\hat{\beta}_{it}$$

2.6. Case4: Using daily data and follows the method of Fama-MacBeth

This case constructed portfolios based on the size sorted beta of portfolio. The data set is made up of 10 years daily data. 10 portfolios are created from the data set. The first portfolio and the last portfolio, respectively, consists of 27 stocks. Each of the remaining 8 portfolios comprises 23 stocks each. This formulation is based on 5 years of daily data. Initial 3-year daily data are used for the time series regression of (1), and the last 2-year in daily data are used for the cross-sectional regression of (2).

4 These portfolios are collected from URL: https://www.hsx.vn/Modules/Listed/Web/SectorOverview on Sep 20,2019

5 "The Adjusted Beta is an estimate of a security's future Beta. Adjusted Beta is initially derived from historical data, but modified by the assumption that a security's true Beta will move towards the market average, of 1, over time. The formula used to adjust Beta is: (0.67) x Raw Beta + (0.33) x 1.0." This method is also called Blooberg method https://guides.lib.uwo.ca/bloomberg/equities.

Table 6 Summary of statistics from the cross-sectional regression

Variable	Mean	Std.Dev	t-value	p-value
$\hat{\gamma}_{0t}$	0.005	0.072	0.373	0.711
$\hat{\gamma}_{1t}$	0.014	0.069	1.138	0.265
$\hat{\gamma}_{2t}$	-0.008	0.030	-1.392	0.175
$\hat{\gamma}_{3t}$	-0.034	0.489	-0.375	0.710

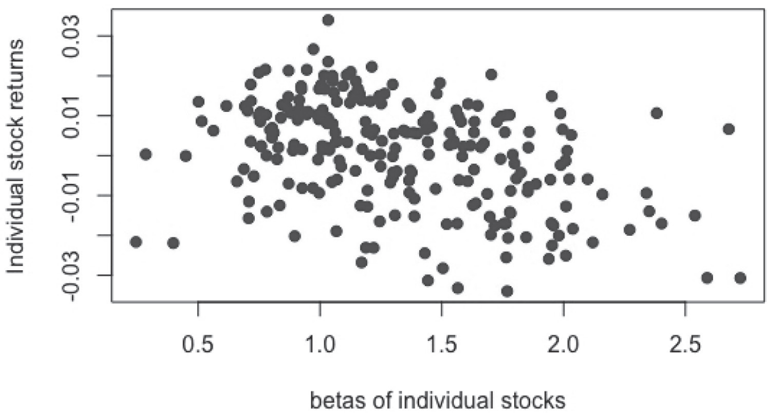
Source: Created by author.

Table 7 Estimated betas of stock returns (from January 2010 to December 2015)

Coefficient	Obs	Mean	Standard error	Min	Max
Beta	238	1.326	0.468	0.244	2.725

Source: Created by author.

Figure 3 Individual stock returns versus betas, period: 2010-2015



Source: Created by author.
Note: (•) denotes the average monthly return and risk of each stock of 238 stocks.

Table 8 Summary statistics for the cross-sectional regression

Coefficient	Mean	Std.Dev	t-value	p-value
$\hat{\gamma}_{0t}$	-0.069	-0.411	-0.839	0.379
$\hat{\gamma}_{1t}$	0.025	0.091	1.485	0.149
$\hat{\gamma}_{2t}$	-0.009	0.029	-1.740	0.093
$\hat{\gamma}_{3t}$	0.214	0.214	0.838	0.409

Source: Created by author.

3. Estinated Results

3.1. The CAPM with portfolio returns on industrial classifications.

Table 2 shows the estimated results of the time series regression of (1). All estimated betas are statistically significant. Table 3 shows the estimated results of the cross-sectional regression of (2). From Table 3, notably, $\hat{\gamma}_{0t}$ is statistically significant in 10%, which implies that it is a positive price of risk in the HOSEs. $\hat{\gamma}_{1t}$ is statistically significant in 5% but it is in negative relationship. $\hat{\gamma}_{2t}$ is also statistically significant in 5% but it is in positive relationship. $\hat{\gamma}_{3t}$ is statistically insignificant, thus null hypothesis is accepted. This implies $\hat{\gamma}_{3t}$ has no linearity in the HOSE, which contrasts the CAPM. Hence, the CAPM based on the portfolios of industrial category do not support the HOSE. The estimated results denote $R_i = 0.063 - 0.176\beta + 0.108\beta^2$. Figure 1 illustrates the estimated results. It illustrates there are several portfolios with high betas but low returns. These estimated results imply there are additional factors that have influenced the expected returns, which are not captured from the estimation.

3.2. The CAPM from collected Individual stock returns data with government bond 5-year

Table 4 shows the summary of the estimated results of betas from the time series regression of (1). There are 238 betas from the HOSE. The beta average of individual securities is 0.825. The minimum is −0.275, and the maximum is 2.224. Table 5 presents quantiles of betas and their average returns. The highest beta is 2.224 that yields average monthly return of −0.030. In contrast, assets with β 0.752 produces 0.003 average monthly return during the whole study period. Figure 2 shows the relationship between beta and monthly returns from 2010 to 2018. This figure does not indicate the linear relationship between average returns and betas. Hence, the estimated results contradict the CAPM.

Table 9 Estimated betas of stock returns (from January 2010 to December 2015)

Coefficient	Obs	Mean	Standard error	Min	Max
Beta	238	0.883	0.312	0.149	1.816

Source: Created by author.

Table 10 Summary statistics for the cross-sectional regression

Variable	Mean	Std.Dev	t-statistic	p-value
$\hat{\gamma}_{0t}$	-0.002	0.095	-0.133	0.894
$\hat{\gamma}_{1t}$	0.022	0.104	1.138	0.265
$\hat{\gamma}_{2t}$	-0.008	0.030	-1.391	0.175
$\hat{\gamma}_{3t}$	-0.034	0.489	-0.375	0.710

Source: Created by author.

Table 11 Estimated results of portfolios for period 2010-2018

Statistic	1	2	3	4	5	6	7	8	9	10	Mean
$\hat{\beta}_{pt}$	0.829	0.785	0.660	0.573	0.344	0.447	0.283	0.346	0.194	0.195	0.465
S($\hat{\beta}_{pt}$)	0.023	0.024	0.030	0.027	0.029	0.026	0.029	0.030	0.031	0.031	0.233

Source: Created by author.

Table 12 Summary statistics for the cross-sectional regression

Variable	Mean	Std.Dev	t-statistic	p-value
$\hat{\gamma}_{0t}$	0.001	0.048	0.177	0.859
$\hat{\gamma}_{1t}$	-0.003	0.054	-1.167	0.243
$\hat{\gamma}_{2t}$	0.003	0.047	1.344	0.179
$\hat{\gamma}_{3t}$	0.044	1.431	0.528	0.597

Source: Created by author.

Table 6 presents the summary statistics of the estimated month-by-month cross-sectional regression coefficient estimates $\hat{\gamma}_{it}$. The results show that $\hat{\gamma}_{it}$. is not statistically significant. Therefore, we cannot reject the null hypothesis. These results mean that the CAPM does not valid in the HOSE market.

3.3. The CAPM from collected Individual stock returns data with interest rate 1 month

This analysis tests the robustness of the CAPM in Vietnam's stock market with special focus on the HOSE. Therefore, beside 5-year government bond as the risk-less rate, the analysis examines the interest rate. The data is collected from the website of State Bank of Vietnam.[6] Table 7 tabulates the estimated betas of stock returns from January 2010 to December 2015. Figure 3 plots the relationship between beta (β_i) and monthly return (R_i) for the 10-year holding period period between January 2010 and April 2018. This scatter diagram confirms non-linearity between beta and average return, which does not support the CAPM in the HOSE.

Table 8 presents the summary statistics of the month-by-month for the estimated cross-sectional regression coefficients. $\hat{\gamma}_{0t}$, $\hat{\gamma}_{1t}$, $\hat{\gamma}_{3t}$ are not statistically significant, thus the null hypothesis is valid. But $\hat{\gamma}_{it}$ is statistically significant at 10%. Hence, CAPM does not necessarily valid in the HOSE.

3.4. The CAPM by using adjusted betas

Table 9 tabulates the estimated the adjusted betas of stock returns of time series regression of (1) from January 2010 to December 2015. The beta average of individual securities is 0.883. The minimum value is 0.149, and the maximum is 1.816. Table 10 presents the analytical results of the cross-sectional regression of (2). All estimated coefficients are not statistically significant, and thus this study can not reject the null hypothesis. This means that the CAPM is not applicable on the HOSE.

3.5. The CAPM with beta sorted size portfolio returns

The table 11 presents the average coefficient of the estimated beta in the cross-sectional regression. The industry portfolios have priced beta risk for monthly data, but this analysis prices beta risk for daily data. Table 12 shows the value of the 10 portfolios $\hat{\beta}_{pt}$ and their standard errors S($\hat{\beta}_{pt}$) for 2-year estimation periods. All estimated coefficients are not statistically significant, which imply the CAPM does not support the HOSE.

4. Conclusions

This study has applied the methodology similar to the two-step Fama-MacBeth procedure for examining the validity of

[6] URL: www://sbv.gov.vn on Jan 4,2020

the CAPM on the HOSE. The analyses have focused on the estimations for both the government bond and interest rate. The estimated results show that by and large beta appears to explain the variation in expected returns, with portfolios and individual stocks. However, in these cases the relationship between beta and expected returns is not linear. Furthermore, the analytical results did not change much even with the adjusted data frequencies.

It is worthy to note that, from the review of earlier studies, this study is the first empirical attempt in clarifying the use of industrial sector for the portfolio formulation in reducing the estimation errors for examining the applicability of the CAMP in Vietnam's stock market. This study is limited, at least, in the availability of data set and the development level of capital market in general in Vietnam. Notwithstanding, the analytical approach of this study undoubtedly will stimulate more empirical works in Vietnam's financial sector. Equally important, this study has provided the essential foundational framework in terms of the application of the CAMP for improving the technical knowhow of portfolios formulation that is vital for making investment decisions.

This research has also contributed to the collection of empirical data necessary for analyzing portfolio management in general and particularly for the application of the CAMP in Vietnam's stock market. This contribution has surely laid the foundation for more similar studies in Vietnam. Nonetheless, this study has encountered two crucial limitations. First, the data set was collected from a variety of sources, which in and of itself has a certain degree of inaccuracies. Second, this analysis did not use variables other than the market return and the risk-free rate of return. This is inevitable because the analytical focus was to examine the excess returns and the risk premium. Having said that, however, it has affected the hypothesis testing with respect to the reliability and the accuracy of the observation and discussion. For this reason, a test on the Vietnam's stock market using the Arbitrage Pricing Model is desirable because it is expected that this approach will bring about analytical results and insights with the use of different variables. This approach can lead to better estimations, which are more reliable for strengthening the understanding of the trade-off in the transaction of securities in emerging economies in general and in Vietnam in particular. This is the future research direction.

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