The Ineffectiveness of Capital Asset Pricing Model and Its Possible Solutions

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ABSTRACT
Capital Asset Pricing Model (CAPM) is one of the most widely used models for estimating returns in the investment world. Many relevant studies have shown that CAPM has different validity in different markets. The ineffectiveness of CAPM does exist according in previous studies. Therefore, this article summarized possible reasons for the ineffectiveness of CAPM, which includes the defects of beta measurement, market portfolio measurement, and three model assumptions. In addition, this paper provided several solutions that may help to ameliorate the negative influence of the defects and increase the accuracy of return estimation, specifically, the robust Least Trimmed Squares (LTS) and Maximum Likelihood type M-estimator (MM-estimator) methods can bring to a more accurate beta, while the Fama-French Model may lead to a more appropriate expected return. It is hoped that this article will help investors to build better investment strategies and provide some reference for the researchers who focus on the study of CAPM.

Keywords：*Capital Asset Pricing Model, Return Estimation, CAPM Testing, Ineffectiveness, Solutions.*

1. INTRODUCTION

The financial market is a good place to improve the efficiency of the use of funds. In the market, people having good ideas while no money to realize could get an opportunity to collect money from the investors and change their dreams into reality.

On the contrary side, people who could provide money are the investors. They are always looking for projects to invest in by doing valuations and comparisons. This part is usually related to estimation model—most of them are calculating the expected return, with which it allows investors to compare the returns for different projects directly and know the length of time for money returning. And there is a return estimation model being widely used until now.

Capital Asset Pricing Model (CAPM), established by William Sharpe, John Lintner and Jack Treynor in 1964, is one of the most popular models in the investment world [1]. It shows the relationship between expected return and systematic risk as following:

$$E(ri) = rf + \beta im(E(rm) - rf) \qquad (1)$$

Considering its effectiveness for different markets in different levels of development, this article analyzed its usage in both developed countries and developing countries and found its various effectiveness for different countries. With the test failures, most people only considered CAPM a bad model. However, when digging into the tests in the past few decades, it was found that the inaccurate parameter values could be another reason. Therefore, this article discussed the reasons that may lead to CAPM ineffectiveness, then proposed some ways to improve CAPM, and further demonstrated some alternative models. It is hoped that the findings could be helpful for investors to decide which model to use in the future and thus improving the accuracy of their return estimation.

The remainder of the article is arranged as follows: Section 2 compares the CAPM effectiveness among countries; Section 3 describes the possible reasons for the failure of the CAPM; Section 4 gives suggestions for

better return estimation by modified CAPM and alternative models; Section 5 provides conclusions.

2. DIFFERENT RESULTS OF CAPM TESTING

Since its inception, the CAPM has been debated by scholars in different fields. Although it has been widely used by investors in investment decision making, its limitations for several reasons have led questions to the validity of this model. Considering the different developmental progress of the capital markets in different countries, we searched for the results of CAPM validity test in both developed countries and developing countries, trying to figure out whether the effectiveness would be diverse in different markets. We chose to represent results from countries including the US, UK, Spain, China, Brazil, India and Indonesia.

2.1. CAPM Validity in Developed Countries

Although the model originated from Western countries with relatively developed capital markets, different countries have come to different conclusions about the results of testing the validity of the model.

According to the empirical evidence of the US market from 2001 to 2011, Sirucek et al. found that coefficient cannot explain the return of a single asset, since the relationship between systematic risk and expected return is weak [2]. Therefore, it is recommended that the CAPM should not be used in the largest stock market in the United States. Similar conclusions have been figured out by Tienyu's team [3]. Those UK market researchers held the view that only when the unsystematic risk and nonlinear relationship between the expected return and beta are considered, will the CAPM be effective. However, the effectiveness of the CAPM has been proven by Spain. In examining whether the CAPM can help investors win the market, Gómez-Bezares et al. found that data of Spain from 2004 to 2006 showed that the CAPM was indeed an effective tool [4].

2.2. CAPM Validity in Developing Countries

Compared to those developed Western countries, developing countries have their backwardness of capital markets and limited research in investment models under the market situation that is more different from the market condition assumed by the CAPM, CAPM tests have provided diverse results with total ineffectiveness, partial ineffectiveness, and effectiveness in different markets. When applying the model to the Indian market, Basu et al. found a negative relationship between beta and excess returns, with the conclusion that the CAPM is not suitable to evaluate the asset in India capital market [6].

For the Chinese market, an empirical study was carried out to test the applicability of the CAPM using trading data from the Chinese Shanghai capital market [6]. It found that there is a positive correlation between the average excess return and systematic risk of Chinese capital market equity portfolios from January 1st, 2013 to January 1st, 2019, which is consistent with the expectations of the CAPM. However, the intercept term of the regression model is not zero, indicating that the CAPM is only suitable for the last 6 years of capital markets and is not fully applicable. Xiao et al. also tested CAPM in China market, while getting the result of partial effectiveness from a different perspective [7]. Testing on data from Shanghai stock market from 2016 to 2017, he showed that CAPM is not effective for the whole market but could be effective for some industries such as information transmission, software and information technology services, manufacturing industry, and financial industry. The model defects were also confirmed by Brazilian data from 1988 to 2012 [8].

Different from the former two results, Roberta argued that CAPM seemed to be valid in Indonesian market [9]. By doing hypothesis tests from four perspectives— looking for zero alpha, positive beta, linear relationship and unrelated unsystematic risk variable—Roberta showed that CAPM should have some explanatory power towards the market.

Our consolidation of existing research shows that model validity tests can show different results in different market environments. Moreover, the validity would changeover different time periods and for different sectors of the market. Therefore, we would explore the reasons why CAPM would show the diverse effectiveness.

3. POSSIBLE REASONS FOR INEFFECIVENESS OF CAPM

In view of the estimation success of the CAPM in Indonesia, we would like to explore the reasons why CAPM is only partially effective in China and Brazilian, and totally ineffective in many other countries. We would like to know whether its failure is due to the inappropriate measurements of the key parameters of CAPM equation or due to the limitations of CAPM itself.

3.1. Inappropriate Measurement

3.1.1. Beta

In the CAPM, considering the relationship between asset return and systematic risk that is measured by beta, incorrect measurement of beta would result in the ineffectiveness of expected return. However, it is believed that beta is hard to be an accurate measure.

Tests in various countries such as the UK [3], Dhaka [10], and Japan [11], all showed failures of CAPM used in both individual assets and portfolio. And all of them applied beta values calculated by monthly returns.

Regarding this, Phuoc showed that beta measured by monthly returns has larger errors and standard deviation than that measured by daily returns [12]. Additionally, he also proved that Ordinary Least Square (OLS) regression method used in many tests, including tests in Dhaka, is not effective enough.

Therefore, the application of monthly returns and the use of OLS regression methods could possibly lead to the incorrect beta and thus the CAPM failure.

3.1.2. Market Portfolio

Market portfolio is another significant part of the CAPM since return premium and beta in the formula are both calculated by the return of the market portfolio. Researchers in several tests for checking the effectiveness of the CAPM in different markets were used to using a market index as the market proxy. However, the market index may not be an appropriate measurement.

The first reason is that market indices are not positioned on the efficient frontier in real life while the on-line position should be the premise of CAPM. According to one of the tests in the Central and Southeastern Europe, researchers used Excel solver to conduct efficient frontier lines in 9 countries and compared them with the local market indices, by which they discovered that all market indices were positioned below the efficient frontier lines [13].

The second reason is that human capital is excluded from the market index. But theoretically, human resource should be included as part of the market assets. A test in Japan market compared the effectiveness of estimation models with and without human capital as a factor, and it considered account human capital by including income from human capital; including income from human capital, the test provided a 75% R-Square relationship between the average return and beta, while this R-Square relationship was only 3% without considering human capital [14].

Therefore, using a market index as an approximation of market portfolio should be an inappropriate way that may lead to the ineffectiveness of CAPM being tested.

3.2. Failure of CAPM Itself

3.2.1. Unsystematic Risk Could Not Be Diversified

CAPM shows that the only variable is systematic risk because risks related to the asset itself could be diversified by investing in various assets—the unsystematic risk tested to be about 1% when a portfolio includes 20 stocks and almost 0 when it includes 100 stocks [15]. However, unsystematic risk does matter.

Within the test done by Gordon and Wai Cheong in

the international market, they studied the relationship between returns, systematic risk, and unsystematic risk that is demonstrated by skewness and kurtosis [16]. They created return-estimated models with these factors, and finally found that both skewness and total risk are playing significant roles in the models, regardless of using equally weighted or value-weighted market returns as the approximation of the market portfolio. And since skewness, a form of unsystematic risk, was tested to be a significant factor in the model, it is proved that even international portfolios were not well-diversified and probably could not be well-diversified.

Hence, unsystematic risk may not be reduced by ideal portfolio diversification as assumed, which would lead to CAPM's estimation failure.

3.2.2. Stable Beta Could Not Be Achieved

For CAPM, it is assumed that beta for a specific asset remains comparatively stable over time, while some evidence show that it is not true.

A test in China stock market strengthened this point of view. It showed that beta is the most stable when estimated by 12-month data and would become more and more unstable as estimation duration increases; In addition, beta is calculated to be more unstable in a bull market than in a bear market, in cyclical industries than in high growth industries, and for large companies than for small companies [17]. Xiao-Ming also showed that betas for different industries in New Zealand are not stable, tested by various statistical modelling techniques such as stochastic volatility model and GARCH model [18].

With different testing methods and comparisons between different data, beta was proved to be unstable, which may be the cause of the ineffectiveness of CAPM.

3.2.3. Assumptions Which Lead to the Ineffectiveness of CAPM

When creating CAPM, there are 6 assumptions [15]:

1. The market is perfect competition that trading by any investor would not affect the asset price.

2. The investment is a one-period action, which means that investors cannot keep updating their portfolios.

3. Only tradable assets are considered, excluding some assets such as private enterprises.

4. Borrowing rate and lending rate are the same at risk-free rate.

5. No tax or transaction cost exists.

6. All investors are rational and having the same assessment criteria towards assets.

Although the models were always created with assumptions that could not be achieved in the real world, this unachievable assumption 6 could still be a reason why CAPM should not be used.

Investors are irrational according to the creation of "Behavioral Finance". They are proved to be irrational by the rocketing stocks in a bull market and the sharply decreasing stocks in a bear market—for example, in 2000 April, NASDAQ index fell from more than 5000 points to around 3000 points in the US stock market [19]. Investors in China stock market also had the same experience—Shanghai Stock Index rocketed from 998 in June 2005 to 6124 in October 2007, after which it drops dramatically to 1664 in October 2008 [20]. At the same time, the assessment criteria are obviously different for investors, without which the large volume buys and sells would not exist in the market. Additionally, investors would react to information with different sentiments: some investors may be optimistic about the current market situation while others may be pessimistic [21]. With these understandings, a stock price should be the sum of the irrational reactions of those investors with heterogeneous beliefs towards the current market condition. Thus, it is random. And since these irrational reactions and current opinions towards the market should have no impact on future reactions and opinions, present price should have no influence on future prices. In this way, β_{im}, calculated by historical returns and prices, should not be used to calculate the expected return. And hence, the CAPM should not be used to estimate future returns.

4. SOLUSIONS TO THE INEFFECTIVENESS OF CAPM

CAPM is wildly used for return estimation. However, with the inappropriate way of measurement and the probable defects of itself, it is not as useful as assumed. Therefore, in order to get better return estimations, the measuring method should be improved, or other more appropriate models should be used.

4.1. Improved Measurements of Beta

Different researchers proposed various ways to improve data and the methods are proven to be useful.

To ameliorate the errors and unstable results of beta measured by the OLS regression model, Phuoc and his group showed two alternative measuring method, the robust Least Trimmed Squares (LTS) and Maximum Likelihood type M-estimator (MM-estimator) methods, which will provide a more accurate and consistent estimation of beta [12]. Additionally, they showed that using daily returns instead of monthly returns could increase the estimation accuracy.

For the same purpose, Gray et al. [22] proposed the

use of Vasicek bias correction to improve the estimation of beta and showed that this correction method is effective in reducing the imprecision of expected return estimated from CAPM.

In conclusion, beta estimates would have more predictive power if measured by robust Least Trimmed Squares (LTS) method, Maximum Likelihood type M-estimator (MM-estimator) methods, Vasicek bias correction, and daily returns.

4.2. Better Market Proxy

The reason for including market portfolio in CAPM is that the market portfolio is the optimized model, lying on the efficient frontier. It can form an optimized portfolio with risk-free asset that would provide the highest return with the lowest risk. And the reason why market portfolio should include all assets in the market is that it is an aggregation of actions which would show collective wisdom, cancel out the irrational actions and infer to the most accurate decision. To conclude, the focus on market portfolio is to achieve the most efficient portfolio. Hence, to ameliorate the errors caused by market portfolio as a market proxy, creating a portfolio with higher return and lower risk could be a better measurement for measuring market return in the CAPM.

A successful case is that Hector found the more efficient portfolios with only few numbers of stocks—he created a portfolio including 8 chosen stocks instead of using the index that includes 32 stocks [23]. After comparing the predictive power of the self-created portfolio and the market portfolio, he discovered that the former portfolio could predict better. In a similar way, Moshe and Richard also create a better portfolio with fewer stocks than in the market portfolio. They used the "reverse optimization" method, changing some of the sample parameters, to find a portfolio with mean and variance not significantly different from the sample mean and variance but changed efficient frontier [24]. And they tested that this portfolio is mean/variance efficient.

In conclusion, fewer stocks may lead to a more efficient portfolio, and it may be a better market proxy than the market index.

4.3. Alternative Models

With "Market Anomaly" that is made up of some market phenomena such as scale effect, value effect, and momentum effect, the single-factor CAPM would be hard to explain the factors and provide appropriate estimations. Therefore, it should be replaced by other models that is fitted to the market and may provide better estimations.

4.3.1. Fama-French Model

$$R_{it} - R_{ft} = a_i + \beta_i(R_{mt} - R_{ft}) + S_i SMB_t + h_i HMI_t + \varepsilon_{it}$$
$$(2)$$

With understandings towards the ineffectiveness of single-factor model used for prediction in the market, Fama-French model, which includes more explanatory variables, could be a better model. This is tested by research using data from the China stock market: By comparing the returns from 6 investment portfolios with the expected return calculated by two models, it showed that Fama-French could be a better model since it had a higher R-Square and a more stable regression coefficient [25]. Fama-French Model includes three factors—market portfolio (RM-RF), market value factor (SMB) and book to market ratio (HML).

4.3.2. Sentiment Endurance (SE) Model

$$R_t = a_t + b_t SE_t + c_t SE_{t-1} + e_t \qquad (3)$$

The Market anomaly is reflected by the rapid ups and downs in the price, and this price is formed by investors with different sentiments towards the same information. To capture the net effects towards asset pricing made by these investors, He [25] put forward an idea that the closing stock price could be a measure of that net effect and created a model with sentiment endurance (SE) index that is calculated by the closing stock price [21].

The three-factor asset pricing model proposed by Eugene Fama and Ken French produced better results than the standard asset pricing model. On this basis, the SE Index, which reflects changes in insurance investor sentiment, is a more accurate predictor of excess returns. Therefore, the SE model consistently outperforms the CAPM and FF models, except for the 12-month rolling forecasts of the Fama-French three-factor model (FF).

5. CONCLUSION

To conclude, this paper has analysed the application of CAPM in countries at different levels of development, collated possible reasons for its ineffectiveness and proposed some revision measures for return estimation, as shown in Table 1.

Table1. Reasons for CAPM Failure and Plausible Improvement Methods for Return Estimation

Defects	Specific Reasons	Solutions
Measurement of Beta is inappropriate	-Monthly returns are used	-Use daily returns instead
	-OLS Estimates is used	-Use robust Least Trimmed Squares (LTS) method, use Maximum Likelihood type M-estimator (MM-estimator) methods, or do Vasicek bias correction
Measurement of Market portfolio is inappropriate	-Market Index does not lie on the efficient frontier	-Create a more efficient portfolio as market proxy
	-Market index does not include human capital	
CAPM itself	-Diversification cannot perfectly reduce unsystematic risk.	Alternative Model -Fama-French Model -Sentiment Endurance (SE) Model
	-Beta is not stable	
	-Assumptions of CAPM may question the usefulness of CAPM	

Comparing the test results of CAPM, it is found that the CAPM is generally ineffective in both developed and developing countries with some exceptions.

This ineffectiveness could be resulted from not only the failure of the CAPM itself, but also the inaccurate measurements. The CAPM defects relate to the unachievable assumptions that unsystematic risks could be perfectly diversified, beta is stable for an asset, and investors are rational and having homogeneous beliefs. Therefore, the inaccurate measurements refer to the inappropriate beta estimates and market portfolio estimates.

Since CAPM could not provide a good prediction of future returns as shown in the former studies, some methods have been collected to improve the accuracy of parameter estimation and proposed some alternative models that may have better predictive power. The findings are hoped to be useful to help investors achieve a better estimation in the future.

In order to have a deeper understanding towards the usefulness of CAPM, this paper proposed the following suggestions:

1. Further research should be put forward in Indonesia to study whether it has some special conditions that

would lead to model success, or it is just a coincidence.

2. The markets for CAPM tests are not perfect due to some policies, such as the limiting ups and downs in the Chinese market that prevent the stock price fully reflecting investors' opinions. Therefore, tests should be redone when the policies are modified to make the market more perfect and complete, which may prove that CAPM is valid.

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