Capital Asset Pricing Model: Its implications and benefits for Corporates

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Abstract: ***The paper describes and analyzes the application of the capital asset pricing model (CAPM) and the single-index model on the Zagreb stock exchange during the drop in the total trade turnover, and mostly in the trade of equity securities. This model shows through the analysis techniques used to estimate the systematic risk per share compared to the market portfolio. Also, the model quantifies the environment in which a company and its stocks exist, expressing it as risk, or a beta coefficient. Furthermore, with respect to the market stagnation, one can also discuss the usefulness of the model, especially if the quality of the input data is questionable. In this regard, the importance of the proper application and interpretation of the results obtained based on the model during the stagnation of the market, and especially during the stagnation of the trade of equity securities, is gaining even greater importance and significance. On the other hand, the results obtained through the analysis of data point to problems arising during the application of the model. It turns out the main problem of applying the CAPM model is the market index with negative returns during the observation period.***

Keywords: Systematic Risk, CAPM, Beta coefficients, Rate of Return.

INTRODUCTION

This is the capital asset pricing model (the CAPM) developed 30 years ago by Sharpe (1964) and Lintner (1965). This model was the first apparently successful attempt to show how to assess the risk of the cash flow from a potential investment project and to estimate the project's cost of capital the expected rate of return that investors will demand if they are to invest in the project. Until recently, empirical tests of the CAPM supported the model. But in 1992, tests by Fama and French did not; they said, in effect, that the CAPM is useless for precisely what it was developed to do. Since then, researchers have been scrambling to figure out just what's going on. What's wrong with the CAPM? Are the Fama and French results being interpreted too broadly? Must the CAPM be abandoned and a new model developed? Or can the CAPM be modified in some way to make it still a useful tool?1 In this article, we don't take sides in the CAPM debate; we merely try to describe the debate accurately. We start by describing the data the CAPM is meant to explain. Tien we develop a version of the model and describe how it measures risk. And finally we describe the results of competing empirical studies of the model's validity.

PURPOSE

The purpose of this paper is to present the theoretical and practical application of the Capital Asset Pricing Model in the case of the Croatian capital market and its function in reviewing investment opportunities. The paper also attempts to discover how well the said model evaluates and describes the measure of systematic risk in the target market.

METHODOLOGY

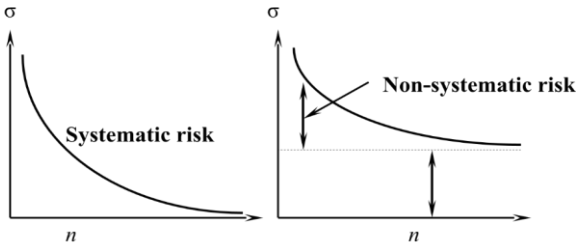
During the writing of this paper, in its first part, the prevalent method was the descriptive method used to describe different approaches to calculating rates of return and standards of their disclosure. Furthermore, the basic characteristics of the CAPM model and its applicability through the single-index model are explained. The basic method used in this paper is a mathematical method. In order to achieve better analysis of the data, in addition to mathematical methods, the methods used include statistical methods through which the relationships between the observed securities and the market index were further explained.

Capital Asset Pricing Model (CAPM):

The modern portfolio theory (MPT) developed by

Markowitz (1952) is one of the key elements helping investors to choose a set of securities that will give them a higher portfolio return with the desired level of risk. This is one of the most popular approaches to designing and selecting portfolios. The criteria, the profitability of the portfolio, which determines the expected return, and the risk of the portfolio as measured by portfolio return variance, are sufficient to meet the preferences of an investor. When applied in practice, the Markowitz's portfolio theory has had a few drawbacks. One of the major problems was the large number of input data in the optimization of the portfolio, and that demands more resources and time during the process of analysis. For example, for a portfolio containing 100 securities, it is necessary to calculate 100 expected returns, 100 variances, and 100 x 99/22 = 4.950 co-variances. And a set of 100 securities is considered to be actually rather small. The model for capital asset pricing (CAPM) was developed by Sharpe (1963, 1964) and Lintner (1965) with the aim to simplify the existing Markowitz's model. They observed the existing correlation between stock returns and the market during the changes in market conditions. Further they split the total return of a security in the return related to the market and the return which is not dependent on the market. They also noted the overall risk of a security can be separated into the systematic and non-systematic risk, that is, in factors causing the risk. The non-systematic risk is the risk which directly affects the volatility of the company's stocks. It is defined by certain decisions of the company's management which caused the lower profitability of the company and ultimately the drop in stock prices. It is important to emphasize that due to designing a portfolio with various securities, the non-systematic risk expressed in standard deviation, i.e. stock return variance, can diversify given the optimal combination of risk and return. The systematic risk is defined by the environment within which a company operates (economic, political, financial, fiscal and legal). From the company's point of view, this is the environment in which it operates, but which cannot be influenced or predicted with certainty. For example, in case of changes of interest rates on the market, indebted companies must pay a higher interest rate on their loans. That way, their profitability decreases, causing the market to responds through a decrease in the value of their stock prices, i.e. returns. Figure 3 shows the relationship between risk and the number of securities in the portfolio from which it is clear that by increasing the number of securities in the portfolio, the non-systematic risk decreases, while the systematic risk remains the same, which sustains the idea of the impossibility of its diversifying. Where: n - stands for the number of securities in the portfolio.

Portfolio Risk as a function of the Number of Stocks in the Portfolio:



A: Company-specific risk B: Market risk and company-specific risk

The CAPM model shows the relationship between risk and equilibrium expected return on a risky asset based on the fact that for investments in the capital market the relevant risk is the systematic one. Since the systemic risk does not decrease with diversification. It is based on certain simplified assumptions that allow the understanding of the essence of the model. After that, it is possible to introduce the complexity of the environment and see how the theory can be extended and modified in order to achieve more realistic and comprehensible results. The first assumption of the CAPM model argues that no investor is big enough to influence individual securities by means of its own trading on the capital market. The second, all investors have the same investment time horizon. The next assumption relates to putting together a portfolio where all investors can build a portfolio out of any publicly available financial assets and are able to give and take loans at a riskfree rate without any limits. The fourth defines the absence of tax and transaction costs when trading securities. The fifth assumption states that all investors are rational, i.e., they seek to design portfolios set on the efficacy threshold. The sixth refers to equal analysis, and the possession of equal information. That is why the estimated probability distribution of future cash flows is identical for all investors. Also, when building an optimal risky portfolio, investors will use the same expected returns, standard deviations and correlations to generate the efficacy threshold and a unique optimal portfolio.

These assumptions, not only enable a better understanding of the process of balancing the prices of securities in the market, but they also have certain

consequences. Firstly, all investors have the same market portfolio (M). For the sake of simplicity, let's call all assets, stocks. The share of each stock in the market portfolio equals the stock's market value (price per stock times the number of stocks issued), divided by the total value of all stocks. The second, the market portfolio will be set on the efficacy threshold. This is also the optimal risky portfolio that is set on the capital allocation line Capital Allocation Line (CAL[1]) and which touches the efficacy threshold of possible portfolios. In other words, the capital market line (CML[2]) is actually the best attainable capital allocation line (CAL). All investors differ among themselves only by the amount of funds invested in a risky portfolio and risk-free assets. The third, the premium on the market portfolio is proportional to the market portfolio variance and the level of investors' aversion to risk:

$$E(r_M) - r_f = A^* \sigma_M^2$$

Where: E(rM) – stands for the expected market portfolio return, r_f – risk-free interest rate, σM^2 – market portfolio variance and A^* – the number representing the level of investors' aversion to risk. The fourth, the risk premium of individual securities will be proportional to the risk premium of the market portfolio (M) and the security's beta (b) in the market portfolio which defines the rate of return of the market portfolio as the only factor in the securities market. From these afore-mentioned assumptions, it is clear why all investors have the same risky portfolios

The Risk Premium and the Expected Return of Individual Assets:

For any risky investment on the capital market, investors want compensation or a reward. Further to the above-said, the logical question for investors would concern the amount of the expected reward compensating the risk taken due to buying risky securities. The reward is defined as the difference between the expected return during the period of investment of risky securities and the rate of return on the risk-free assets. Most investors believe that the instruments of the money market are adequate risk-free assets. The difference between risky and risk-free assets is defined as a risk premium.

$$Risk\ premium = R_i - r_f$$

Where: R is the total return on a security *i*, r_f *is* rate of return on the risk-free assets. CAPM defines a risk premium of an asset as a contribution of the risk of total assets in the investor's portfolio. In other words, if the risk of individual assets increases the risk of the total investor's portfolio, the premium for the risk of individual assets must be higher. Since the non-systematic risk can be reduced to a large proportion by efficient diversifying of the portfolio, investors demand a reward for the risk only for the portion that relates to the systematic risk, which explains the fourth consequence of the assumptions stating the risk premium of individual assets will be proportional to its beta:

$$\frac{E(r_M)-r_f}{} = \frac{E(r_i)-r_f}{\beta_i}$$

The ratio of the total expected return and the beta of the CAPM model is expressed in the formula:

$$E(r_i) = r_f + \beta_i\left[E(r_M) - r_f\right]$$

Where: E(ri) is the expected return of individual assets, bi is the individual assets' beta, while other symbols are the same as before. The formula shows the total expected return of individual assets is greater than the risk-free assets for the risk premium, which is calculated by multiplying the systematic risk (measured using the beta) and the market portfolio's risk premium.

The Single-Index Model and CAPM:

Taking into consideration the above-mentioned assumptions, the CAPM model may restrict investors. The reason for that is the assumed market portfolio that should consist of a variety of assets (real estate, foreign stocks, precious metals, etc.). Also, the assumed market portfolio is the optimal portfolio of risky assets and should be set at the efficacy threshold, which requires its construction and analysis. Furthermore, the CAPM employs expected, rather than actual portfolio's and stock's returns. It is a known fact that the actual returns during a certain investment period are rarely equal to their forecasts.

Calculating the Historical Beta using the Regression Model

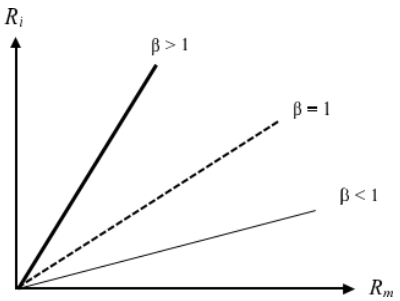
Depending on the input data used for calculating a beta coefficient, betas are calculated as: historical (ex post) beta coefficients, expected (ex ante) beta coefficients and expected adjusted (ex ante) beta coefficients. Historical beta coefficients are calculated on the basis of historical input data on the returns of individual assets and the market portfolio.

There are two possible modes of calculation: (a) using the regression model of the dependent and independent variable, (b) using the method of calculating the relationship between two variables expressed by the covariance and variance of the market portfolio. Since the calculation of the expected beta coefficients requires drafting the expected probability distribution of possible scenarios in the economy, which demands a larger data repository and previous analyses. In this paper I will present the calculation and interpretation of historic beta coefficients by means of the regression analysis. The example will demonstrate the calculation of historical betas using the regression line equation. The regression line equation is given in the formula:

$$R_i - r_f = \alpha_i + \beta_i (R_M - r_f) + e_i$$

Where: R_i is the actual return on individual securities, a_i is the stock's rate of return beyond the market yield, e_i is the company-specific events affecting solely the security in question, R_M is the actual market yield (index), other symbols are as before.

Return on a Security as a Beta Function

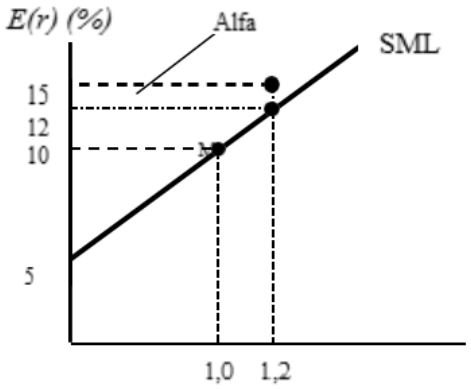


The Security Market Line

The relationship between the expected return and beta can be shown graphically using the stock market line (SML[3]). Since beta is a measure of the systematic risk measuring standard deviation of the market portfolio, investors expect a reward for the risk taken that is proportional to the increase of the portfolio risk, so the risk premium demanded by investors is a beta function:

$$\beta \left[E(r_M) - r_f \right]$$

Security market line-SML



The stock market line is used to evaluate investment performance and presents a standard in the evaluation of investment results. For a risk measured by the beta, SML defines the required rate of return which will compensate for the investor's risk. If the expected rate of return for an individual security, or a portfolio. Calculated using, for example, the fundamental analysis, is higher than the expected rate of return adjusted by the beta, or a formula that uses the CAPM model, the security would be considered undervalued. On the other hand, overvalued stocks have a lower expected return than the return that is corrected by the beta. To calculate the expected rate of return for individual securities that are corrected by the beta, we use the already mentioned formula (13) of the CAPM model:

$$E(r_i) = r_f + \beta_i \left[E(r_M) - r_f \right]$$

How the CAPM Helps Corporate Managers:

Models like the capital asset pricing model (the CAPM) help corporate managers by providing them with a practical way to learn about how investors judge the riskiness of potential investment opportunities. This helps managers use the resources of their firms more efficiently. The Manager's Problem In modem industrial economies, managers don't easily know what the firm's owners want them to do. Ownership and management are typically quite separate. Managers are hired to act in the interests of owners, who hold stock in the corporation but are otherwise not involved in the business. Owners send some general messages to managers through the stock market. If stockholders do not like what managers are doing, they sell their stocks, and the market value of the firm's stock drops. The representatives of stockholders on the firm's board of directors notice this and turn to the managers for corrective action. In this way, therefore, stock prices act like an oversight mechanism. They monitor the

activities of managers by aggregating the opinions of the stockholders. However, stock prices don't act fast enough. They don't give managers specific directions ahead of time about which projects to pursue and which to avoid. Managers must make these capital expenditure decisions on their own and then later find out, by the stock market's reaction, whether or not the firm's owners approve. Disapproval can be costly. In the United States in 1992, for example, capital expenditures by the corporate business sector (excluding farming and finance) totaled $397 billion (or 6.6 percent of the annual gross domestic product). These expenditures usually cannot be recovered if stockholders disapprove of them.

The Classic Solution:

In view of this, capital budgeting has a central role in both the theory and the practice of managerial finance. Theory suggests one simple rule for corporate managers to follow when making capital expenditure decisions: Maximize the value of the firm. Then, if some stockholders disagree with management decisions, they can sell their stock and be at least as well off as if management had made different decisions. This idea is the basis for the classic theoretical recommendation that managers only invest in those projects which have a positive net present value. In practice, however, following that simple rule is not simple. It requires, among other things, estimating the net present value of every project under consideration. Corporations thus spend a substantial amount of resources evaluating potential projects. A key input to that process is the cost to the firm of financing capital expenditures, known more simply as the cost of capital This is the expected rate of return that investors will require for investing in a specific project or financial asset. The cost of capital typically depends on the particular project and the risk associated with it. To be able to evaluate projects effectively, managers must understand how investors assess that risk and how they determine what risk premium to demand.

The CAPM's Role:

Providing such an understanding is the focus of most research in the area of asset pricing. An asset pricing model provides a method of assessing the riskiness of cash flows from a project. The model also provides an estimate of the relationship between that riskiness and the cost of capital (or the risk premium for investing in the project). According to the CAPM, the only relevant measure of a project's risk is a variable unique to this model, known as the project's beta. In the CAPM, the cost of capital is an exact linear function of the rate on a risk-free project and the beta of the project being evaluated. A manager who has an estimate of the beta of a potential project can use the CAPM to estimate the cost of capital for the project. If the CAPM captures investors' behavior adequately, then the historical data should reveal a positive linear relation between the average return on financial assets and their betas. Also, no other measure of risk should be able to explain the differences in average returns across financial assets that are not explained by CAPM betas. Empirical studies of the CAPM have supported this model on both of those points—until recently, as the accompanying article describes.

CONCLUSION

With respect to the examined possible application of the model, and the results obtained accordingly, this paper can be divided into two parts. The first part, describes the calculation of beta coefficients and the obtained results, the second part which relates to the application of the CAPM model in calculating the adjusted rate of return by means of beta coefficients. The advantage of calculating beta coefficients using the regression analysis, i.e. of the application of the CAPM model in the calculation of the adjusted rate of return is evident in its practicality. This is also the main advantage of the CAPM model, as opposed to the MPT theory. The logical question that arises is the question of reliability of the obtained results. He also points out that in the case of less liquid stocks, the correction of betas must be greater and vice versa.

The goal of every investor is to achieve as high of a return on the invested capital as possible and to reduce the risk of losing the invested capital. With regard to this assumption, the application of the formula of the CAPM model is put under scrutiny. As it has already been mentioned, the average index return is a negative value, which is why the application of the formula would be in contrast with the principles of every rational investor.

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