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The Development of CAPM Model and Its Application in the Field of Corporate Finance

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Abstract: In the modern financial world, when investors make capital market investments, they are often confused about what kind of portfolio can bring the maximum benefit return with the minimum risk. This paper mainly studies the theoretical basis of CAPM and the application field of the model. In order to clearly summarize the CAPM model, this paper evaluates and summarizes the relevant research results of CAPM in stock investment and structure optimization in different literatures through the method of literature review. Finally, this paper finds that CAPM, as a single factor model, is convenient for users to calculate data, but in the actual use of the market, it is not suitable for investors to rely on because of too idealized assumptions and the risk coefficient.

Keywords: Gordon model, CAPM, stock investment, capital structure, WACC

1. Introduction

In the process of financial management such as investment and financing, a company often needs to evaluate its assets through reasonable calculation and analysis of its financial situation, and at the same time effectively allocate the company's working capital to obtain returns and form a suitable capital structure. On the basis of Portfolio Theory that Harry Markowitz came up with and Capital Market Theory, several American academics known as William Sharpe, Jack Treynor, John Lintner, and Jan Mossin created the Capital Asset Pricing Model (CAPM) in 1964, which is applied in this situation. The model mainly examines how the equilibrium price is determined and how expected return rates of assets and risk assets relate to one another on the securities market. The CAPM serves as the cornerstone of contemporary financial market pricing theory and is heavily utilized in corporate finance and investment decision-making [1]. In the research field of this model, there have been a lot of literature on its advantages and disadvantages, but there is a lack of comprehensive summary. This paper will summarize the development and application of CAPM in securities investment, capital cost calculation and capital structure optimization by way of literature review, and finally point out its inevitable defects. The research of this paper will provide a comprehensive reference for the researchers of CAPM model application in the future.

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2. Background and Theoretical Basis of CAPM

2.1. Model before CAPM

Prior to the 1960s, there was no accurate measurement of stock market risk and return, but researchers had enough computing power to collect data and process it for the purposes of scientific investigation. Fisher and Lorie, after conducting the first careful investigation and study on the return rate of stocks listed on the New York Stock Exchange, were surprised to point out in their paper that "so far there is no measurement method that is considered accurate and can be determined to measure the return rate of ordinary stocks" [2]. Therefore, in the 1950s, before the development of CAPM, the mainstream tools used by financial markets to estimate the expected return on investment assumed that the return required by investors depended mainly on how the asset was financed, and they mainly involved two kinds of capital costs, namely the cost of debt capital and the cost of equity capital. The cost of debt capital is considered the interest rate owed on the debt, while the other one is deducted from the cash flows investors expect from the stock, which is related to the current price of the stock. The Gordon model provided the corresponding formula as a popular calculation model for estimating the cost of capital at that time [3]. In this model, the company's dividend is assumed to grow permanently at a constant rate g. When the current dividend per share of the company is D and the stock price is P, then the cost of equity r is calculated as:

$$r = D/P + g^2 \quad (1)$$

From the standpoint of contemporary finance, this approach to calculating the cost of capital is based on the irrational presumption that risk does not directly affect the cost of capital calculation. The cost of equity capital should be decided by the cost of capital of assets, not the other way around. However, extrapolating the cost of equity capital from projected dividend growth rates is a highly subjective process. More specifically, a business with high cash flow growth due to high dividend growth would be judged to have a high cost of equity capital by such an extrapolation method, when in fact there may be no real link between the cost of capital and cash flow according to the capital asset pricing model [4].

2.2. Theoretical Basis of CAPM

Based on the problem of the expected return of investment and the possible linear relationship between risky assets, Harry Markowitz proposed the asset portfolio theory in 1952, which became one of the most important theoretical bases for the development of CAPM model. He believed that due to the broad economic environment, various risky assets are correlated to some extent, so investors can take advantage of holding a diversified portfolio to eliminate some of the associated risks. In later research on how the advantages of diversification rely on asset correlation, Markowitz stated that the correlation between two assets gauges the extent to which they fluctuate together, and the correlation coefficient varies between -1.0 and 1.0. When the coefficient is positive 1, the two assets are entirely positively linked, and on a function picture, it may be seen as a point moving proportionately in the same direction. This means that the two assets are substitutes for each other. When the coefficient is negative 1, on the other hand, the asset return is entirely negative, indicating that when one asset grows, the other asset will decline in a given ratio. Otherwise, the return of one asset cannot be anticipated if the return of the other asset is known when the correlation coefficient is 0. This occurs when there is no relationship between the two assets. More specifically, suppose asset A and asset B need to be invested, and asset risk is measured according to the standard deviation of returns. Assuming ρ as the correlation between the two assets, assets A and B are represented by σ_A and σ_B respectively, x is the proportion of investment A, y (=1-x) is the proportion of investment

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B, then when ρ=1, knwon as the compelete positive correlation, the weighted average of each asset's risk is called the portfolio's risk [5]. The formula for investment risk can be derived as follows:

$$\sigma_p = x\sigma_A + y\sigma_B \tag{2}$$

When assets are not perfectly correlated (p is less than 1), there is a nonlinear relationship, in which part of the risk of one asset will be offset by another asset, and the standard deviation of the portfolio is always smaller than that of a single asset. Meanwhile, the farther the correlation is from 1, the greater the benefit of risk diversification. Two important insights are concluded:(1) Diversification depends on poorly linked individual risks rather than uncorrelated individual hazards; (2) The correlation of individual asset returns limits the risk reduction potential of diversification [6].

Another indicator that the CAPM formula relies on is the Sharpe ratio. When a portfolio has risky assets and risk-free assets, risk and expected return are linearly combined, and the slope of this line is called the Sharpe ratio, which can be expressed as:

$$Sharp\ Ratio = (E_x - r_f)/\sigma_x \tag{3}$$

Among them, Ex refers to the average return rate of all investments in the portfolio, r_f refers to the return rate of risk-free investments, and σ_x refers to the volatility of the return rate of the portfolio, which is simply the risk premium of risky assets divided by the risk. The Sharpe ratio allows investors to allocate wealth between the portfolio with the highest ratio and risk-free assets with greater risk tolerance. The application of the CAPM formula derived from these two theoretical bases will be discussed in the next section.

3. Fields Refer to CAPM

3.1. Stocks Investment

By combining the projected rate of return with the risk, the CAPM, one of the most well-liked financial instruments on the capital market, may assist investors in determining whether companies are worthwhile purchases. Its benefit is that the model is straightforward, simple to use, and does not rely on arbitrary assumptions about dividend growth. If the market portfolio has the greatest sharpe ratio in an equilibrium condition, increasing or removing holdings of any asset will not cause the Sharpe ratio to rise. The anticipated return of a portfolio of risk assets may be determined using the formula that Sharpe and three others successfully created:

$$E_{Ri} = r_f + \beta(E_{Ra} - r_f) \tag{4}$$

In this formula, E_{Ri} is the expected rate of return, r_f is the average risk-free rate of return, β coefficient is introduced which reperent stock risk measurement and E_{Ra} is the average market rate of return.

The specific application is reflected in Erric Wijaya and Alecia Ferrari's research on Indonesian banking sector stocks. They grouped the effective and inefficient stocks of 40 listed banking companies from 2016 to 2018, and selected 31 stocks with effective returns. In their study, they first analyzed the return Ri of individual stocks based on monthly closing prices collected in the market, and then calculated the actual return of the individual [7].

Then, after calculating the individual stock return, they calculated the expected return of the stock based on the beta coefficient and CAPM formula, which is shown in table 1：

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Table 1: The Expected Rate of Return in 40 Banks [7].

No.	Bank List	ERi (%)	No.	Bank List	ERi (%)
1	Mitraniaga	1.15	21	Sinar Mas	0.53
2	Ganesha	0.88	22	Nationalnobu	0.53
3	Harda Internasional	0.83	23	Woori Saudara Indonesia 1906	0.51
4	Bukopin	0.81	24	Bumi Arta	0.50
5	CIMB Niaga	0.78	25	Arto Indonesia	0.49
6	Danamon Indonesia	0.78	26	Mestika Dharma	0.47
7	Artha Graha International	0.04	27	Maspion Indonesia	0.46
8	Agris	0.76	28	Maybank Indonesia	0.45
9	Jabar Banten	0.74	29	Nusantara Parahyangan	0.45
10	Rakyat Indonesia	0.70	30	Victoria International	0.44
11	Tabungan Negara	0.69	31	Permata	0.44
12	Mandiri	0.65	32	Ina Perdana	0.42
13	Pan Indonesia	0.64	33	Capital Indonesia	0.39
14	Mega	0.62	34	MNC Internasional	0.38
15	Central Asia	0.62	35	Pembangunan Daerah Banten	0.37
16	Tabungan Pensiunan Nasional	0.61	36	Mayapada International	0.34
17	Pembangunan Daerah Jawa Timur	0.55	37	Rakyat Indonesia Agro Niaga	0.28
18	China Construction Bank Ind	0.55	38	Negara Indonesia	0.02
19	QNB Indonesia	0.54	39	Dinar Indonesia	0.02
20	OCBC NISP	0.54	40	Yudha Bhakti	0.01
Source: (Processed by Erric Wijaya and Alecia Ferrari, 2018)					

Finally, through the comparison of individual return and expected return, it is concluded that the individual return is greater than the expected return is effective stock, otherwise it is inefficient stock. In total, there are 31 efficient stocks and 9 inefficient stocks. Since the investment criterion is to choose efficient stocks, the best investment decision for inefficient stocks is to consider selling them.

3.2. Optimize Capital Structure

The CAPM model can be used to optimize capital structure because it can help a firm determine the cost of its equity capital. If a company's cost of equity is lower than its cost of debt, the company can raise money by issuing more stock instead of borrowing. Doing so can reduce the company's financial risk and increase shareholder value. In J. Mark Smith's case study, his CAPM's risk premium formula is applied to his portfolio XYZ to analyze the stocks of ten companies in the investment. At the same time, after further studying the risk index beta and weighted average cost of capital, he drew an inference and conclusion on how enterprise management will be optimized.

First, the researchers compare the XYZ portfolio to the market to determine the portfolio's beta. The return of the S&P 500 index is defined in the study as the average Market Return (E_{Ra}) in the CAPM equation, which is mentioned in the formula in the previous section. This is because the S&P (Standard and Poor) index is derived from monthly returns over a long holding period and is readily available from reports by business research firms. At the same time, the yield on long-term US Treasury bonds can also be defined as the average risk-free rate of return, because Treasuries are

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often considered risk-free assets due to their extremely low risk. Additionally, the market risk premium in CAPM, which is approximately 5.5%, is the average difference between the annual yield of all stocks and the yield of long-term national government bonds (r_f = 3.29%). Using these estimates to calculate the expected yield of XYZ without deriving ERa, CAPM's 10-year investment horizon (E_{Ra} - rf) may be 5.5% [8]:

$$E_{xyz} = r_f + \beta(0.055) = 0.0329 + 0.5734 * 0.055 = 6.44\% \quad (5)$$

A 5.5% market risk premium can be tested by quickly looking at the price of the S&P 500 index from July 1, 1978 to July 1, 2022[9]. The average yearly return for the 44 years examined is 9.87%, thus 9.87% − 3.29% may be used to compute the new market risk premium, so the updated result is:

$$E_{xyz} = r_f + \beta(0.0987 - 0.0329) = 0.0329 + 0.5734 * 0.0658 = 7.06\% \quad (6)$$

As the β came from table 2:

Table 2: Cost Basis for Evaluating β of Portfolio XYZ [10].

Company Ticker	β	Cost Basis in $	Weight	Stock Beta's Weight
ADM	0.77	170	0.056	0.0431
CVS	0.72	278	0.092	0.0662
JNJ	0.61	857	0.283	0.1726
KDP	0.65	78	0.026	0.0169
MRK	0.34	591	0.195	0.0663
OXY	1.86	63	0.021	0.0391
PEP	0.56	167	0.055	0.0310
PG	0.34	311	0.103	0.0350
KO	0.54	273	0.090	0.0486
TSN	0.70	236	0.078	0.0546
Totals		3,024	1.0	
The Portfolio's β				0.5734
Source: Marketwatch.com (no date, b).				

From the above calculation, it can be seen that the expected annual return of the portfolio is much lower than the long-term market expectation. Due to its relatively low beta coefficient, this means that the asset portfolio is a defensive portfolio, which means that the asset portfolio will be more stable under the continuous decline of the stock market under a longer investment period.

Then, different expected returns are calculated by comparing Gordon model and CAPM, the researcher finds that when Gordon model and CAPM are applied to calculate the expected returns of the same asset portfolio, some company management may further evaluate the returns of the current capital structure after averaging the expected returns of the two models. When such differences occur, for investors who want to avoid risks, they are more likely to use CAPM and compare the differences between CAPM and Gordon model to see if these are general problems. For management, their desire for high stock values led to an aggressive dividend policy. Factors such as the large demand for the product and high market share all contribute to the ability to achieve high dividend growth, which is particularly prominent in TSN [11].

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Moreover, a review of KO's capital structure shows that its debt is very high but cheap, which supports the formula called Weighted Average Cost of Capital (WACC), where weighted debt and equity determine the capital cost [12]. A third of the long-term debt which is 13.2 billion dollars carries an interest rate of just 0.4%, and some long-term debt as late as 2098 carries an interest rate of 6%. However, in 2021, KO's long-term debt-weighted cost is only 1.7%. According to its calculations in the CAPM equation, the risks brought by dividends are moderate, while high debt is offset by good interest rates [13].

Finally, the capital structure is crucial for obtaining money and preserving the company's financial stability, as these two corporate financial assessments have demonstrated. The capital mix of long-term investments that are essential to operating income should be taken into account. Using the WACC methodology, which calculates the cost of different types of debt in long term and equity, such changes are simpler to comprehend. For instance, a company aiming for a capital structure of 30% long-term debt and 70% equity may have yearly weighted average costs of debt and equity of 7% and 13%, respectively. Since debt interest is tax deductible, debt-related expenses are calculated as debt times (1-T), assuming that T is a 30% effective tax rate. As a result, WACC for the desired capital structure may be calculated as:

$$WACC = [30\% * 7\%(1 - T)] + (70\% * 13\%) = 1.47\% + 9.1\% = 10.57\% \quad (7)$$

It is obvious from this calculation what the effects of the effective tax rate may be: The cost of debt will rise when the effective tax rate T is reduced, increasing the WACC. With the aim of balancing WACC and minimizing the negative effect of these changes on the capital structure, management will either cut debt or reduce equity to maintain the same total cost of capital [9].

4. Limitation of CAPM

After the application of the above two fields, it can be seen that as a single factor model, CAPM formula is more convenient and simple in application than Gordon model, and it supports investors to have more diversified portfolios.

However, its existing problems can not be ignored. First, the assumptions provided by CAPM are too idealistic, such as its assumption of risk-free assets. A completely risk-free interest rate cannot exist in a real capital market, even for a low-risk product like a Treasury bond. At the same time, interest rates do not remain constant, on the contrary, interest rates should fluctuate in actual conditions. Such fluctuations indirectly lead to the difficulty of determining the beta coefficient.

5. Conclusion

In summary, capital asset pricing model, as one of the pillars of modern financial market price theory, plays an important role in securities investment and optimizing capital structure. However, when it is used, it needs to conform to the hypothesis of the theory, such as the non-existence of transaction costs, which leads to its defects in an overly idealized state. In addition, there is still room for improvement in this study. Since this paper uses the method of literature review to summarize and evaluate, the data cited in the study is limited to a small number of sample data and individual cases, so it may lack universality. If we want to find the universality of CAPM, we need more sample data and research literature. For future researchers, CAPM model can only be used as a theoretical reference framework and can not be fully applied to the actual company operation. At the same time, more researchers are needed to develop and fill the gaps in CAPM.

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