

The Limitations and Evolution of the CAPM Model

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Abstract. The Capital Asset Pricing Model (CAPM), first introduced by William Sharpe and others, has been an important part of modern finance. This model is based on a simple idea: the expected return of an asset depends on its market risk, as measured by beta. This idea is applied in many areas, such as estimating the cost of capital, managing portfolios, and evaluating investment performance. But over time, more data have shown that CAPM has limitations. It does not fully explain the differences in returns between different assets. As a result, new models incorporating more factors have been developed. These models add things like company size, book-to-market ratio, and past return trends (momentum). These models aim to deliver more reliable and accurate results. This study integrates theoretical analysis and empirical data to examine the effectiveness of the Capital Asset Pricing Model (CAPM) in typical scenarios. Furthermore, using historical return data and regression analysis, the study compares CAPM with several multifactor models. The results show that CAPM has some clear weaknesses. However, it retains its value: rather than discarding it, we can regard it as a starting point, upon which better models can be built to explain asset prices more effectively and align more closely with real-world data.

Keywords: CAPM, Asset Pricing, Model Application, Risk Factors

1. Introduction

The Capital Asset Pricing Model (CAPM) was developed by Sharpe [1], Lintner [2], and Mossin [3]. It is a key idea in modern finance. CAPM says that the expected return of an asset comes from one main thing—its market risk, called beta. The model is simple. People use it a lot. It helps to find the cost of capital, check fund results, and choose investments.

However, over time, markets have evolved, and CAPM has been subjected to extensive testing, often yielding unsatisfactory results.

Many studies show that it cannot explain all the return differences between assets. Accordingly, new models have been developed, which incorporate additional factors such as company size, value, past return trends (momentum), and corporate profitability.

The CAPM also has theoretical limitations: it assumes that markets are always efficient, investors always act rationally, and risk and return remain constant over time. However, both recent research and real-world market events indicate that these assumptions do not always hold.

This paper elaborates on the core concepts of CAPM and examines whether the new multifactor models perform better. The objective is to understand the evolution of asset pricing models and their

practical applications in financial practice.

2. The CAPM in practice: applications and enduring value

The Capital Asset Pricing Model (CAPM) was made by Sharpe [1], Lintner [2], and Mossin [3]. It is still one of the best-known and most used models in finance today. Despite criticisms of its limitations, CAPM remains relevant in practical financial contexts. The main idea of CAPM is simple: the return people expect from an asset depends on how much risk it has compared to the market, as measured by a metric known as beta. This clear link between risk and return is used a lot in business and investing.

In company finance, CAPM is often used to find how much it costs a company to raise money through its own shares. It is integral to tools such as Net Present Value (NPV) and Discounted Cash Flow (DCF), which require reliable estimates of future returns. As Brealey, Myers, and Allen [4] said, CAPM is easy to understand and good for helping company managers make choices, even if they are not experts in finance. In real cases like project planning, choosing how to raise money, or valuing a company for a merger, CAPM is liked because it is simple and clear.

In investment work, CAPM is also important. It assists in evaluating portfolio performance and assessing its risk exposure. Managers use it to calculate beta, which indicates an asset's sensitivity to market movements. The model also provides a benchmark for alpha, a measure of excess return relative to the market-adjusted expected return. Fama [5] highlighted the utility of CAPM in separating skill-based returns from those due to systematic exposure. This framework enables asset managers, investors, and fund evaluators to interpret returns in a standardized manner, facilitating decisions related to fund allocation and performance attribution.

Furthermore, CAPM's conceptual framework indirectly supports regulatory frameworks. While modern risk regulations (e.g., Basel III [6]) do not rely exclusively on CAPM, the model's logic underpins the broader understanding of systematic risk and equity risk premiums employed in risk-weighted capital calculations and stress testing. Its assumptions and logic also serve as a reference point for stress scenarios and systemic risk analysis.

Nonetheless, CAPM's practical applications are not without limitations. The model assumes market efficiency, homogeneous expectations, and stable relationships over time—conditions that rarely hold in practice. Roll [7] emphasized that the model is inherently untestable because the true market portfolio is unobservable, while later studies [8] demonstrated that beta alone does not fully explain cross-sectional variations in returns. These limitations are more pronounced during periods of market turmoil or structural change, where the assumptions of equilibrium and rationality break down.

Nevertheless, CAPM retains value as a 'first-order approximation' [9], serving as a conceptual foundation upon which more flexible and empirically robust models have been built. Rather than being discarded, it continues to provide a theoretical and practical baseline that informs modern financial analysis and decision-making across various domains.

3. Limitations of the CAPM: theoretical simplification and empirical weaknesses

Although the CAPM has played a foundational role in asset pricing theory, its theoretical assumptions and empirical performance have been widely challenged. The model is predicated on idealized conditions: investors are rational and risk-averse, markets are frictionless and informationally efficient, and all agents hold homogeneous expectations. Assets are infinitely

divisible, and investment horizons are single-period and static. These simplifications provide mathematical elegance but severely constrain real-world applicability [9].

One of the most influential critiques comes from Roll [7], who argued that the CAPM is inherently untestable because the true market portfolio—comprising all investable assets including human capital—is unobservable. Empirical tests typically use stock market indices such as the S&P 500 as proxies, resulting in biased beta estimates and misinterpretation of alpha. Moreover, numerous empirical studies show systematic anomalies that CAPM fails to explain. For instance, Banz [10] found that small-cap stocks tend to generate higher returns than predicted, while Fama and French [11] demonstrated that both size and value effects contradict CAPM's single-factor explanation.

CAPM's simplicity makes it attractive for teaching and for use in practice, particularly in corporate finance and regulation. However, this simplicity can lead to misuse or over-reliance. Beta estimates, typically derived from historical returns, are often unstable over time—particularly in volatile or evolving markets [12,13]. Moreover, the model assumes linear, time-invariant relationships between risk and return—relationships that do not reflect the dynamic nature of financial markets.

Another limitation is CAPM's disregard for behavioral influences and macroeconomic uncertainties. Behavioral finance has documented various investor irrationalities—such as overconfidence, herding, and short-termism—that violate rational expectations [14]. Additionally, modern investment decisions are influenced by non-market risks, including ESG factors, political instability, and global economic shocks. These are not captured in the model's framework of a single systematic risk factor.

Finally, the growing use of multi-factor models like the Fama-French three-factor and five-factor models, or the Carhart four-factor model, reflects CAPM's diminishing explanatory power in empirical asset pricing. While CAPM remains an elegant and useful theoretical starting point, it is increasingly viewed as a “first approximation” rather than a comprehensive model of asset pricing [15].

4. Future directions of asset pricing models: beyond CAPM

As financial markets evolve in complexity and investors' demands diversify, the future of asset pricing models lies in addressing the limitations of CAPM through broader, more flexible frameworks. A study published in the *Journal of Financial Economics* (2025) shows that the “low-beta anomaly” remains difficult to explain using the CAPM. Even after controlling for investor sentiment and arbitrage constraints, high-beta stocks continue to underperform low-beta stocks.

Over the past few decades, numerous new models—referred to as multi-factor models—have been developed. These are called multi-factor models. These models incorporate additional factors into CAPM to better explain return differentials. The Fama-French three-factor and five-factor models include factors like company size, value, profitability, and how much a company invests [16,17]. Recent research has shown that factor momentum, rather than just individual stock momentum, plays a significant role in explaining cross-sectional returns across global markets. This supports the continued relevance of momentum in modern asset pricing models [18].

Contemporary researchers are leveraging computational methods and big data to enhance these models. Machine learning facilitates the identification of new factors through the analysis of large datasets. These new methods go beyond simple linear or average-based relationships; they can identify more complex time-varying patterns [19].

Another approach emerges from behavioral finance, which posits that investors do not always act rationally or logically. They can be too confident, follow others blindly, or change their feelings too fast. Such behaviors can impact asset prices; accordingly, some models attempt to incorporate these behavioral elements [13].

There is also growing attention to ESG—environmental, social, and governance factors. More investors now care about things like climate change, fairness, and good company behavior. So, new models may need to include ESG risks and chances [20].

One big problem is that new models can get too complex. They may work well with data but are hard to understand or explain. Future models need to stay clear and simple, while still being strong and useful.

5. Conclusion

The Capital Asset Pricing Model (CAPM) has long been a cornerstone of asset pricing theory. Its clear logic and simplicity have made it influential in both academic research and practical finance. It is used to estimate the cost of capital, evaluate portfolio performance, and understand the risk-return relationship.

However, as more data has become available and markets have grown more complex, it has become evident that relying solely on market risk to explain returns is insufficient.

To address this limitation, researchers have developed multi-factor models. These models incorporate factors such as firm size, value, and momentum, and can better explain returns in many scenarios.

Nevertheless, these models have their own shortcomings. These factors may not perform consistently over time or across different markets, and some models may be overly complex or overfitted to historical data, making them difficult to apply and interpret.

Rather than discarding CAPM, it is better to treat it as a simple yet useful foundation. Better models can be built upon it—models that offer greater explanatory power while remaining transparent and practical.

In summary, while CAPM is not perfect, it serves as a valuable starting point. Future models should aim to better explain real-world markets while remaining accessible and applicable. In this way, theory and practice can align to keep pace with the rapidly evolving financial landscape.

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