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A CRITICAL EVALUATION OF ASSET PRICING MODELS: CAPM, APT, AND THE FAMA-FRENCH MULTIFACTOR MODEL

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Boynazarov Shokhruhmirzo
Mustafakulova Sabina
Mustafakulov Ishnazar
Djurayeva Zilola

Introduction

Asset pricing models are part of the financial instruments for understanding and approximating expected returns on financial assets, including stocks, bonds, real estate and etc. Asset pricing models are vital for investors, portfolio managers and financial analysts since they determine the relationship between risk and return to make informed decisions about investment strategy or portfolio management and adjustment. Asset pricing models assists investors in making decisions that allow them to maximize the return and minimize the risk of their investment portfolios by quantifying the relationship between an asset's risk and its expected return (Fervent, 2021).

There are many types of asset pricing models that have been used throughout the history of finance. However, this research discusses three well-known models that have had a significant impact on the development of financial science: arbitrage pricing theory (APT), capital asset pricing model (CAPM) and Fama-French multifactor model. One of the most popular models is the capital asset pricing model CAPM, which describes a linear relationship between an asset's expected return and its market risk, expressed through the asset's beta. Arbitrage pricing theory (APT) assumes that asset returns depend on many systematic factors, making it more flexible than the CAPM. Fama-French models extend the CAPM by adding other factors such as size and value, providing a more sophisticated view of the risks affecting asset prices (Fabozzi, 2008).

The purpose of this paper is to critically discuss the fundamental assumptions on which the APT, CAPM and Fama-French models are based, assess their validity and offer an empirical and theoretical critique of the models themselves. This study contains: the basic concepts of each APT, CAPM and Fama-French model, an analytical and critical discussion of each model supported by empirical evidence, a comparative analysis of the models, and a conclusion summarizing the evaluation of the models and their implications for asset pricing and portfolio management.

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The Capital Asset Pricing Model (CAPM)

The link between the expected return and risk of investing in securities is described by CAPM. It demonstrates that the risk-free return plus a risk premium, which is determined by the investment's beta, equals the predicted return on that security.

$E(R_i) = R_f + \beta_i*(E(R_m) - R_f)$

$E(R_i)$ - Expected return on a security

R_f - Risk-free rate

β_i - Sensitivity

$E(R_m)$ - Expected return of the market

The anticipated returns of an asset are computed using the CAPM formula. It is predicated on the notion that investors must get a risk premium in order to be rewarded for systematic risk. A rate of return higher than the risk-free rate is known as a risk premium (Kenton, 2024).

Despite the fact that the Capital Asset Pricing Model (CAPM) is one of the frequently used methods for determining the value of equity assets, it, like any other model, has a number of limitations and weaknesses that should be taken into account before applying it in practice.

The CAPM assumes that a market portfolio consisting of all risky assets worldwide is understandable and replicable by investors. In addition, assumes that the market portfolio is efficient, that is, it provides maximized possible returns for a given degree of risk. However, according to Zucchi (2024), a market portfolio may be inefficient due to market constraints, irrational behaviour, or other variables, and in practice it is extremely difficult to identify and quantify all the risky assets in the world.

The CAPM calculation assumes that financial markets are free from imperfections or constraints that could have an effect on asset prices. In addition, it does not take into account that investors cannot borrow and lend at the same risk-free rate and trade without any taxes or transaction fees. Furthermore, it is assumed that leverage and short selling are unrestricted. However, in practice, there are taxes, transaction fees and restrictions on lending or borrowing that can cause inefficiencies or distort the market value of assets. There is also a spread between the active and passive rates. This is how banks make financial institutions make profits (Stanculescu, 2016).

Another CAPM weakness is that it does not take into account the fact that investors may be irrational, as they base their decisions on cognitive biases, emotions or asymmetric information. It also ignores that each investor has a different preference of level of risk, that is, CAPM assumes that an investor may

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prefer less risk to more risk for the same level of return. In addition, investors are assumed to have homogeneous expectations, that is, they accept the expected returns, variances, and covariances of all assets (FasterCapital, 2024).

Arbitrage pricing theory (APT)

The linear relationship between the expected return of an asset and macroeconomic variables that affect the risk of the asset is used in arbitrage pricing theory (APT), an asset pricing theory, to predict the return of an asset. The purpose of APT is to determine the fair market price of a security that may be temporarily mispriced. It assumes that market activity is not always fully efficient, which sometimes results in assets being mispriced, either overvalued or undervalued, for a short period of time (Hayes, 2020).

$$E(R_i) = R_f + \beta_1 * RP_1 + \beta_2 * RP_2 + \beta_3 * RP_3 + \ldots + \beta_n * RP_n$$

$E(R_i)$ - Expected return on a security

R_f - Risk-free rate

β_i - The asset's price sensitivity to factor

RP_i - The risk premium associated with factor

The arbitrage pricing theory formula's beta coefficients are estimated by comparing historical securities returns to the macroeconomic component using linear regression analysis (Hayes, 2020).

The well-known Arbitrage Pricing Theory (APT) asset pricing model uses a number of variables to explain how risk and expected return of an asset are related. According to the paper (Cabrera, 2024), compared to other models, such as the Capital Asset Pricing Model (CAPM) or the Fama-French multi-factor model, APT allows the user to select the most relevant components for their study, rather than prescribing which ones to use. Nevertheless, APT also has some limitations that need to be taken into account before application. Descriptive analysis of the weaknesses of APT and a comparison to other asset pricing models from different perspectives provided below.

How the factor risk premiums are calculated and why the factors impact the predicted returns are not well or consistently explained by APT. Instead, then using any economic or behavioural theory to establish the elements, APT lets the user determine them empirically. This indicates that APT just reflects the patterns seen in the data; it has no predictive or explanatory potential. Furthermore, APT doesn't outline how many elements should be employed or how to choose them from the vast array of potential factors. As a result, APT is a statistical or descriptive model as opposed to an economic or normative one. Because various users may employ different elements, methodologies, or criteria for their research, APT also makes it

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challenging to assess its validity or compare its performance with other models (Brandon Gaille, 2018).

To estimate factor betas and risk premiums for each asset and each factor, APT requires a lot of information and calculations. Especially for large and dynamic portfolios with multiple assets and factors, this can be expensive and time-consuming. In addition, APT requires constant updating and monitoring of elements and their values, which can change over time due to events, developments and market conditions. This can affect the accuracy and consistency of the model, adding uncertainty and instability. In addition, APT assumes that there are no market arbitrage opportunities, which means that the required return on all assets is equal to the expected return. Because of market constraints, transaction costs, or other constraints that prevent investors from taking advantage of mispricing, this may not actually be the case. Because of feedback effects, spill over effects, or endogeneity issues that can change the causality and direction of the relationship between variables and returns, APT also makes the assumption that factors are exogenous and independent of asset returns, which in practice may not be the case (Cleverly, 2023).

Fama and French Multi-factors Model

The Fama-French multi-factor model is an extension of the Capital Asset Pricing Model (CAPM). The Fama-French model seeks to describe stock returns using several factors such as, market risk, the outperformance of small-cap companies over large-cap companies, and the outperformance of companies with high book-to-market value over companies with low book-to-market value (CFI Team, 2023).

$$E(R_i) = R_f + \beta_1*(R_m - R_f) + \beta_2*(SMB) + \beta_3*(HML) + \varepsilon$$

$E(R_i)$ - Expected rate of return

R_f - Risk-free rate

β_i - Factor's coefficient (sensitivity)

R_m - Expected return of the market

SMB - Historic excess returns of small-cap companies over large-cap companies

HML - Historic excess returns of value stocks (high book-to-price ratio) over growth stocks (low book-to-price ratio)

ε - Risk

Small Minus Big (SMB) is a size impact based on a company's market capitalization. SMB measures the historical surplus of small capitalization companies to large capitalization companies. As soon as the SMB is defined, its beta coefficient (β) can be estimated using linear regression.

The value premium is known as High Minus Low (HML). It shows the difference in returns between firms with a high book-to-market value ratio and those with a low ratio. Similar to the SMB factor, linear regression can be used to estimate the beta coefficient (β) of the HML factor once it has been identified.

One of the weaknesses of Fama-French Model is several elements were chosen without a clear theoretical rationale, and the Fama-French model does not explain why the market should set their prices. The factor premiums and loadings are estimated from historical data, thus the model is primarily empirical. The potential for the factors to evolve over time or for additional ones to surface in the future is not taken into consideration by the model (Allen and Mcaleer, 2021).

As variables of the Fama-French model are not orthogonal and may be linked with each other or with other variables, it may lead to multicollinearity and measurement error. It can be challenging to determine the separate impacts of each component on stock returns due to multicollinearity, which can also cause instability and imprecision in the calculation of factor premiums and loadings. When proxies or approximations, such as, book-to-market or market capitalization ratios, are used to build factor portfolios, measurement inaccuracies can arise (Lam, 2005).

Last but least, there may be other elements or anomalies that the Fama-French model is unable to account for, which might hinder its ability to capture all the pertinent sources of risk and return in the market. For instance, Studies have shown, for instance, that equities with excellent quality, low volatility, or good earnings surprises typically provide larger returns than the model had anticipated. These anomalies might cast doubt on the model's accuracy and comprehensiveness while simultaneously providing chances for businesspeople to take advantage of market imperfections and produce surplus profits (Farid, 2018).

Conclusion

The Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT) and the Fama-French multifactor model offer different basis for understanding the relationship between risk and return in asset pricing. CAPM is a simple and widely used approach based on the relationship between market risk and expected return. However, its reliance on restrictive assumptions such as market efficiency, homogeneity of expectations and exact portfolio performance in a global market limits its practical applicability.

On the other hand, APT offers an innovative approach by permitting several risk factors. However, this focuses more on the practical aspect of selection as well as factor interpreting gaining no theoretical support. These critical weaknesses

leads to lack of practical use of APT apart from recognition of some potential problems.

The Fama-French model builds on CAPM by adding size and value factors as additional variables that better explain cross-sectional stock returns. However, the empirical basis of the FF is its weakness because of the problems such as multicollinearity, measurement errors, and the omission of other risk variables which quite a number of anomalies are likely to affect.

While these models have significantly advanced financial theory and practice, their limitations underscore the fact that asset pricing research is still not completed. There is a constant need for fresh empirical evidence and new theoretical developments in order to remove the lack of real-life application of these models in fast paced financial markets. Since one model cannot be relied upon to explain all the market complexities, these models should therefore be used in conjunction with one another and prudently by investors and analysts depending on the context and assumptions inherent in each model.

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