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RECONCILING THE ARBITRAGE PRICING THEORY (APT) AND THE CAPITAL ASSET PRICING MODEL (CAPM) INSTITUTIONAL AND THEORETICAL FRAMEWORK

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ABSTRACT: *This paper examines the development of the capital assets pricing model (CAPM), which was developed by William Sharpe and John Lintner. It also looked at the various assumptions of CAPM and APT, and the contribution of Ross to the Arbitrage Pricing Theory (APT) in explaining the relationship between risk and return. The CAPM indicates that a linear relationship exists between a security required rate of return and its beta. The empirical verification of risk-return relationship indicates the mean-variance efficiency of the market proxy.*

KEYWORD: Capital Asset Pricing Model, Arbitrage Pricing Theory, Reconciliation.

INTRODUCTION

The Mechanical complexity of the Markowitz's portfolio model kept both practitioner and academics away from adopting the concept for practical use. Its intuitive logic however spurred the creativity of a number of researchers who began examining the stock market implications that would arise if all investors use this model. As a result, what is referred to as the Capital Asset Pricing Model was developed.

The Capital Asset Pricing Model (CAPM) has been used for many decades, as one of the best tools for analyzing the risk-return trade-off of investors and considered one of the main contributions of academic research to financial manager. The only way an investor can get a higher return for his or her investment is by talking a higher risk (Black, 1972). The CAPM, in essence, predicts the relationship between the risk of an asset and its expected return. This relationship is very useful in two important ways. First, it produces a benchmark for evaluating various investments. For example, when we are analyzing a security we are interested in knowing whether the expected return from it is in line with its fair return as per the CAPM. Second, it helps us to make an informed guess about the return that can be expected from an asset that has not yet been traded in the market. For example how should a firm price its initial public offerings of stock? An alternative approach to characterization of expected return on risky securities is the Arbitrage Pricing Theory (APT) proposed by Rose (1976). Its advantage is that, several empirical studies have concluded that the Arbitrage Pricing Theory can be verified empirically. The Arbitrage Pricing Theory along with the Capital Asset Pricing Model (CAPM) is one of two influential theories on asset pricing. The Arbitrage Pricing Theory differs from the Capital Assets Pricing Model in that; it is less restrictive in its assumption. It allows for an explanatory as opposed to statistical model of asset returns. It assumes that each investor will hold a unique portfolio with its own particular array of betas, as opposed to the identical market portfolio (Diacogiannis, 1984).

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THEORETICAL FRAMEWORK

The Capital Asset Pricing Model (CAPM) is based on Markowitz (1959) and Tobin (1958), who developed the risk return portfolio theory, based on the utility model of Von Neumann and Morgenestern (1953). The implication of the CAPM is the mean variance efficiency of the market portfolio. The efficiency of the market portfolio implies that there exist a positive linear relationship between expected returns and market betas, and that variable other than beta should not have power in explaining the expected return of stocks.

The Capital Asset Pricing Model (CAPM) was developed by William Sharpe (1964) and John Lintner (1965). This resulted to a Nobel price for Sharpe in 1990. The CAPM was builded on the model of portfolio choice developed by Harry Markowitz (1959). For more than four decades now, the CAPM is still widely used in application such as estimating the cost of capital for firms and evaluating the performance of managed portfolio.

The attraction of the CAPM is that, its offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Rigorous testing by financial economist of the seminal era led to the development of Capital Asset Pricing Models to evaluate the risk/return characteristic of securities and portfolios. William Sharpe (1964) who developed the capital asset pricing model, defined risk as volatility relative market. A stocks cost of capital (the investors expected return) is proportional to the stock risk relative to the entire stock. The Capital Asset Pricing Model (CAPM), a true revolution in finance theory which took place in the sixties, describes the relationship between market risks and expected returns of all types of assets, which are financial and real assets. Finance scholars have spent a lot of time and energy to test the theory starting from early seventies. Earlier studies mainly by Black, Jensen and Scholes (1972), and Fama and MacBeth (1993), found some support for the theory in its original form.

However, Roll (1977), raised important objections to these studies arguing that the only testable thing in CAPM was mean-variance efficiency of the market proxy. According to Roll, if the proxy to market portfolio was mean–variance efficient, CAPM would always hold and vice versa. Moreover, Roll sees any effort to test CAPM as useless, since the market portfolio is not identifiable, and can not be proxy by a single factor like stock market index. In fact, Roll became a strong supporter of Ross's Arbitrage Pricing Theory (APT) as the alternative explanation to risk-return relationship. However, Arbitrage Pricing Theory (APT) could not replace CAPM in finance, probably because of the complexities encountered in its empirical testing.

Roll's critics never discouraged finance scholars in their effort to test CAPM, conversely, most of them found his critics very useful because Roll reminded them the relationship between the mean-variance efficiency of market proxy and the resulting validity of the theory. If this is so, empirical verification of risk return relationship would means mean-variance efficiency of the market proxy used.

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LINEAR RELATIONSHIP OF CAPITAL ASSET PRICING MODEL AND ARBITRAGE PRICING THEORY

The Capital Asset Pricing Model (CAPM) tells us that a linear relationship exist between a security's required rate of return and its beta. This relationship called the security market line (SML) is given as follow:

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

$$\beta_i = \frac{COV(R_i R_m)}{\partial^2_m}$$

Where

$E(R_i)$ = Expected return on security i
R_f = Risk Free Rate.
$E(R_m)$ = Expected return on market portfolio
β_i = Beta of Security i

$COV(R_i R_m)$ = Covariance of return on security i with the returns on the market portfolio.

∂^2_m = Variance of returns on the market portfolio.

The expected return on security i is = Risk free return + Risk (Price per unit)

Therefore, the price per unit of risk is = $\frac{E(R_m) - R_f}{\partial^2_m}$

The measure of risk is: ∂im.

The risk of a security is expressed in terms of its covariance with the market portfolio ∂im.

Therefore, we can find a standardized measure of systemic risk, popularly called beta (β_i) by taking advantage of the relationship.

Thus; $\beta_i = \frac{\partial im.}{\partial^2 m}$

Where

(β_i) = Slope of a linear regression relationship in which the return on security i is regressed on the return on the market portfolio.

Thus; the SML is popularly expressed as: $E(R_j) = R_f + [E(R_m) - R_f]\ \beta_i$

While the Arbitrage pricing Theory introduced by Ross provides another model for explaining the relationship between return and risk. APT unlike CAPM, does not assume that investors employ mean-variance analysis for their investment decisions. In APT, the return of an asset is assumed to have two components, predictable (expected) returns and unpredictable (uncertain) returns. Thus, returns on asset j will be $E(R_j) = R_f + U_r$.

Where:

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R_f = Predictable (expected) returns

U_r = Unanticipated (uncertain) returns

The predictable or expected returns depend on the information available to shareholders that has a bearing on the share prices. The unpredictable or uncertain returns arise from the future information (Chandra, 2008). The basic idea of the APT model is that investors can create a zero–beta portfolio with zero net investment. If the zero–beta portfolio constructs with zero investment yields non-zero (positive) return, the same portfolio can be made by arbitraging.

ASSUMPTIONS OF CAPITAL ASSET PRICING MODEL AND ARBITRAGE PRICING THEORY.

The CAPM made a number of assumptions these includes:

- The investor's objective is to maximize the utility of terminal wealth: - the investor is maximizing wealth or returns itself. Utility is a way of describing the differences in individual preferences given the investors wealth. The total utility (or satisfaction) he or she obtains will depend upon the combinations of risk and return that are available (Bhalla, 2009).
- Investor makes choice on the basis of risk and return: - risk and return are measured by the variance and the mean of the portfolio returns. The CAPM assume that portfolio variance is an appropriate measure of risk because it allows us to use two factors, mean and variance, to describe each asset relative attractiveness.
- Investors have homogenous expectation of risk and return: This assumption simply states that all investors' estimates of risk and return are the same. To have a single efficient frontier of modern portfolio theory, we must have consensus estimates of the mean and variance and thus, of the relative value of each investment.
- Investors have identical time horizon: - This assumption suggests that investors form portfolio to achieve wealth at a single, common terminal rate. That single, common horizon allows us to construct a single period model. The model implies that investors buy all the assets in their portfolios at some undefined but common point in the future.
- Information is freely and simultaneously available to investors: - if group of investors were privy to special, not widely available information on which they could make superior decision, market would not be efficient and the CAPM would be affected.
- There is a risk–free asset and investors can borrow and lend unlimited amount at the risk- free rate: the risk–free asset is needed to simplify the complex fair wise covariance of Markowitz's theory. The risk free asset simplifies the curved efficient frontier of the CAPM, and the investor has ceased to be concerned with the characteristics of individual assets. Instead, the investor can create a portfolio from his or her own risk preferred combination. Risk is decreased or increased by adding a portfolio of the risk free asset or by borrowing at the risk free rate to invest additional funds in the market portfolio.
- There are no taxes; transaction costs restrictions on short-rate or other market imperfections: This assumption has several implications for the CAPM. First, the assumption about a risk free asset. Roll (1986), showed that there must be either a risk-free asset or a portfolio of short sold securities for the capital market line to be straight, if there were no risk free asset, the investor could create one by short selling securities.

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If there are no risks free asset the investor could create a proxy risk free asset, the capital market line would not be a linear and the direct linear relationship between risk (beta) and return would not exist.

- Total asset quantity is fixed and all assets are marketable and divisible: This assumption suggests that we can ignore liquidity and new issues of securities. If such things cannot be ignored, then the simple CAPM cannot capture all that is important in pricing securities.

On the other hand, the APT hinged on certain key assumptions, these are:

- Investors seek return tempered by risk. They are risk averse and seek to maximize their terminal wealth.
- Investors can borrow and lend at risk free rate.
- There are no market frictions such as transactions costs, taxes or restrictions on short selling.
- Investors agree on the number and identity of the factors that are important systematically in pricing assets.
- There are no riskless Arbitrage profit opportunities.

LIMITATIONS OF THE CAPITAL ASSET PRICING MODEL:

The Capital Asset Pricing Model (CAPM) has a number of limitations some of which are:

i. It is based on unrealistic assumptions: - CAPM is based on a number of assumptions that are far from the reality. For example, it is very difficult to find a risk free security. A short term highly liquid government security is considered as a risk free security. It is unlikely that the government will default, but inflation cause uncertainty about the real rate of return.

ii. It is Difficult to test the validity of CAPM: Most of the assumptions of CAPM may not be very critical for its practical validity. The empirical results have given mixed results. For example, earlier tests showed that there was a positive relation between return and betas. However, the relationship was not as strong as predicted by CAPM. Further, these results revealed that returns were also related to other measures of risk, including the firm specific risk. In subsequent research, some studies did not find any relationship between betas and returns.

iii. Betas do not remain stable overtime: Beta is a measure of a security's future risk. But investors do not have future data to estimate Beta. What they have are past data about the share price and the market portfolio. Thus, they are only estimate beta based on historical data. Investor can use historical beta as the measure of future risk only if it is stable overtime.

THE LINKAGE BETWEEN THE CAPM AND THE APT:

Despite the apparent conflict between the CAPM and the APT there are still areas of agreement. For example, both CAPM and APT agree on their assumptions that investors can borrow and lend at risk free rate and there are no market frictions such as transactions costs, taxes or restrictions on short selling. Sharpe (1985), agree that there is no need for conflict between the CAPM and the APT, since the beta coefficient of a security (which is the only

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firm specific variable in the CAPM) is the weighted average of the betas of the relevant factors, with the security's sensitivities to the factors. Thus, $\beta_i = b_{i1}\ \beta_{f1} + b_{i\,2}\ \beta_{f\,2} + \text{---} + b_{i\,n}\ \beta_{f\,n}$

Where

$b_{i\,1}$	=	Sensitivity of security 1 to economic factor 1
$b_{i\,2}$	=	Sensitivity of security 2 to economic factor 2
$b_{i\,n}$	=	Sensitivity of security n to economic factor n
$\beta_{f\,1}$	=	Beta of factor 1 with the market portfolio
$\beta_{f\,2}$	=	Beta of factor 2 with the market portfolio
$\beta_{f\,n}$	=	Beta of factor n with the market portfolio.

According to Sharpe (1985), if returns are generated by an **n** factor model of the APT, then the equation can be combined with the CAPM to yield;

$$ER_i = RF_R + b_{i\,1}\,(R_m - RF_R)\ x\ \beta_{f\,1} + b_{i\,2}\,(R_m - RF_R)\ x\ \beta_{f\,2} + \ldots\ldots\ldots + b_{i\,n}\,(R_m - RF_R)\ \beta_{f\,n}$$

Thus;

The CAPM will be: $ER_i = RF_R + \beta_i\,(R_m - RF_R)$

The APT will be: $ER_i = RF_R + b_i\,(R_i - RF_R)$

CONCLUSIONS

The capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965) builds on the model of portfolio choice developed by Harry Markowitz. The attraction of the CAPM is that, it offers powerful and intuitive predictions about how to measure risk and the relation between expected return and risk. However the empirical verification of risk-return relationship shows the mean-variance efficiency of the market proxy. The Arbitrage Pricing Theory (APT) introduced b Ross (1976), provided another model for explaining the relationship between return and risk. While a good number of assumptions were made by CAPM and APT, the CAPM tells us that a linear relationship exist between a security's required rate of return and its beta.

RECOMMENDATION

The purpose of this study is to critically examine the capital asset pricing model and the Arbitrage Pricing Theory and the relationship between the two models using the empirical evidence. During the course of the study, areas of agreement between CAPM and APT where identified. Also there are some limitations that are associates with CAPM which need to be addressed. In the light of the above, the following recommendations are offered.

Investors and other investment companies should try to use a multiple –factor model, as the security return are affected by a number of factors, such as expectations about future levels of real GNP, about future interest rates and expectation about future levels of inflation. These

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factors while they impact on the return on the market portfolio, may impact on the returns of different securities.

If this multiple factor model is accepted, investment managers could be able to use the Black, Jensen and Scholes (1972), model in the analysis of the securities and to understand a way to increase their return with least cost.

The Government should institute a sound macroeconomics policy to check inflation so as to, reduce the uncertainty associated with the real rate of return.

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