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On the Effect of Capital Asset Pricing Model on Precious Metals and Crude Oil Investments

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Abstract: Capital asset pricing model (CAPM) is a useful technique in portfolio management theory (PMT), it is based on a class of risk; the systematic risk associated with the fluctuation of security price that cannot be diversified away. Beta (β) is the measure of the systematic risk, which has a positive correlation with the expected return. Consequently, the investors' aim is to make an optimal choice that will lead to the minimization of risk and maximization of return. To achieve this aim, standard theoretical and computational procedures must be followed. One way of doing this is to construct and analyze models capable of effectively minimizing risk, and proffer suggestions that would improve the return on investment. This paper investigates the relationship between risk and expected returns for investing in Precious metals and crude oil for five consecutive years: 2012 to 2016, using the CAPM. Two striking results were obtained from this research as control mechanisms for potential investors. First, it is revealed that the higher the value of (risk), the higher the expected returns for investing in Precious metals and crude oil. Second, the lower the risk associated with the Precious metal and crude oil's investment, the lower the expected returns.

Keywords: Beta Coefficient, Risk, Returns, Asset Pricing, Portfolio Management

1. Introduction

Portfolio management (PM) is the centralized management of multiple projects, programs, and possible portfolio. The development of portfolio theory in the early 1950s was credited to Professor Harry Markowitz. Markowitz examined how investment returns could be optimized, and the Financial Analyst had long understood the common sense of diversifying a portfolio, the expression: "*do not put all your eggs in one basket*". Markowitz showed how to measure the risk of various securities and how to combine them in a portfolio to get maximum return for a given level of risk. He later developed a framework according to which the decision maker's utility is a function of two variables (the expected returns of a portfolio and its risk). Thus, he formulated that the maximization of the decision-makers' utility as a two-objective problem (maximizing the expected returns of a portfolio and minimizing the corresponding risk). To consider the return and risk, Markowitz used two well-known statistical measures (mean and variance), i.e., "*the mean of all possible returns to estimate the return of the portfolio and the variance to measure its risk*". On the basis of this mean-variance framework, Markowitz developed a mathematical framework to identify the efficient set of portfolios that maximize return at any given level of risk. Given the risk aversion policy of the investor, it is possible to select the most appropriate portfolio from the efficient set. See, for example, the excellent use of diversification technique in the spirit of Markowitz's mean-variance as in [1-5].

William Sharpe in 1964 [6] developed the CAPM. As at then, he was a Ph.D. candidate at the University of California, Los Angeles, in need of a doctoral desertification topic. *He had read "portfolio selection", Markowitz's seminal work on risk and returns 1952 [7] with a later update in 1959 [8]: 'efficient frontier of optimal investment'. While advocating a diversified portfolio to reduce risk, Markowitz stopped short of developing a practical means to assess how various holdings operate together or correlate. Sharpe accepted Markowitz's suggestion that he will investigate portfolio theory as a "thesis" project, by connecting a portfolio to a single risk factor. Sharpe independently developed a heretical notion of investment* *"risk and reward", a sophisticated reasoning that has become known as the CAPM.* The model rattled investment professionals in the 1960s and its commanding importance still reverberates today [9]. In 1990, Sharpe's role in developing the CAPM was recognized by Noble Price Committee. Sharpe shared the Noble Memorial Price in 1990 with Markowitz and Merton Miller. Sharpe also set out most of his findings in his 1970 book "*Portfolio theory and capital market*" [10]. He clearly classified the idea that individual investment contains two types of risk: Systematic risk (non-diversifiable) and Unsystematic risk (diversifiable risk). The unsystematic risk is associated with each asset. Since the investor buys a specific asset, the flat individual must bear the risk associated with each specified investment. The systematic risk is associated with fluctuation in security price. The beta (β) is used to measure the non-diversifiable risk which indicates how the price of a security responds to market forces. This systematic risk leads to the development of the CAPM. However, their emphasis only stressed on systematic and unsystematic risk but returns were not taking into much consideration. Hence, this paper emphasizes on both systematic (non-diversifiable) risk and the corresponding expected returns, with the use of CAPM.

The remaining parts of this paper are organized as follow: section two reviews the literature, section three presents the methodology. Data analysis and results were considered in section four while section five concludes the paper.

2. Literature Review

Portfolio Management (PM) was developed in the nineteenth century when investors were searching for better measures of risk. There was little access to information and few ways of processing even that limited information in the eighteenth and the nineteen centuries. Not surprisingly, the risk measures used was quantitative. Investors in the financial markets during that period defined "risk" in terms of stability of income from their investments in the long term and capital preservation.

In [14], Graham argued against measures of risk based upon past price (volatility), noting that price declines can be temporary and not reflective of a company's true value. He argued that risk comes from paying too high price on security; relative to its value and those investors should maintain a "margin of safety" by buying securities for less than their true worth. In [15], Friedman and Savage constructed the concept of univariate risk aversion which implies that when facing choices with comparable returns, agent tends to choose the less-risky alternatives. The work in [16] and [17] reduced the complexity of the portfolio choice problem and provided insights into the management risk.

Modern academic finance is built on the proposition that markets are essentially rational. The initial model of market rationality is the CAPM. In the pioneer work, Markowitz motivated financial researchers to develop new portfolio management techniques. Significant contributions have been made over the past decades; one of the contributions is the approach in the introduction of the CAPM which is used to predict the expected return associated with any given risk. This model was first developed by Sharpe in 1964 [6] and some parallel works were also done by Lintner (1965) [11], Burton (1998) [9], and Fama and French (2004) [12], all independently building on the earlier work of Harry Markowitz on diversification and modern portfolio theory (MPT), this marked the birth of asset pricing theory. The CAPM is still widely used in applications such as estimating the cost of capital for firms and evaluating the performance of managed portfolios [13].

There has been a vast literature on the general MPT with emphases on the Markowitz's mean-variance theory and the Sharpe's CAPM, see for example, [1-5], [18-23]. In particular, the work in [1] investigates the correlations between metals and oil investments using the diversification model. Also, the estimation of the risk associated with the correlated assets; checking for upward and downward trend of the Precious metals and oil investments were investigated in [1]. Furthermore, the work in [2] used the Black-Litterman technique (BLT) of 1990 in an elegant manner to optimize method for investing in assets. The BLT is known to be based on two famous approaches: the knowledge from CAPM and the Markowitz mean-variance optimization model [24]. It offers a systematic way of estimating the optimal portfolio weights under some given parameters. Since risk is more of great concern in portfolio management, we examine its totality which encompasses the systematic risk and unsystematic risk in Figure 1.

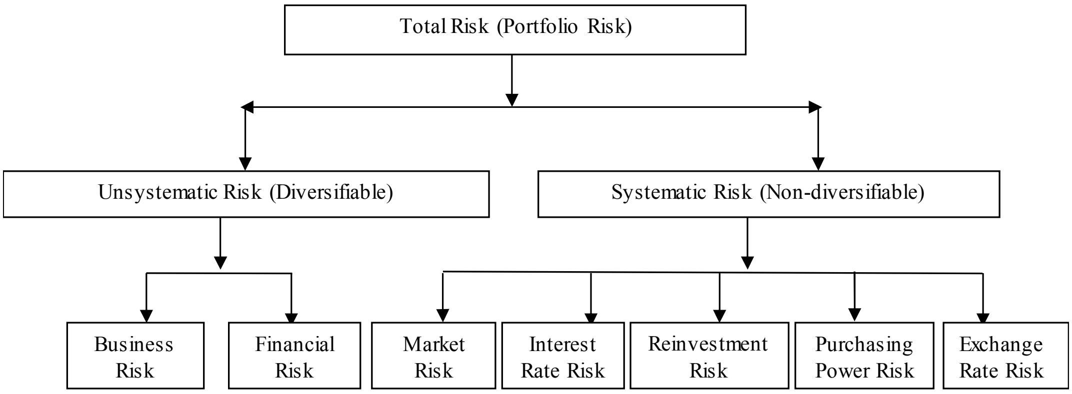

Figure 1. *Portfolio Risk, Source: [22].*

3. Methodology

This section presents the model describing the relationship between risk and expected returns. As in [8], the most efficient portfolio is the one that is tangent to the efficient frontier. Hence, we state the portfolio return as in [8],

$$R_p = R_f + \left[\frac{R_m + R_f}{\delta_m}\right]\delta_p, \qquad (1)$$

where R_p is the return of the portfolio, R_f is the risk-free rate, R_m is the return of the market portfolio, δ_m is the standard deviation of the market portfolio, δ_p is the standard deviation of the portfolio. In market equilibrium, it is expected that the security provides a return to compensate for the level of unavoidable risk. Investors are compensated only for bearing systematic risk. Moreover, that the contribution of a single security to the risk of a large diversified portfolio depends solely on the systematic risk of the security as measured by its beta (β). The CAPM shows the relationship between risk and expected return of a security and its unavoidable risk, and provides a framework for the valuation of securities [21]. As it was mentioned earlier, CAPM is constructed to determine the relationship between risk (β) and expected returns $E(R)$ of the Precious metals and crude oil investments. Hence, we analyze each parameter in the CAPM: the evaluation of the risks (β_i) of an asset i; the risk-free rate (R_f); expected returns on the market portfolio $E(R_m)$; covariance of returns security on market portfolio m, $Cov(R_i, R_m)$; variance of market portfolio $Var(R_m)$; and the expected returns $E(R_i)$ on asset i for Precious metals and crude oil. The general form of the CAPM is given by:

$$E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right], i = 1(1)N, N \in \Re, \qquad (2)$$

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)}$$

$$Cov(R_i, R_m) = \frac{1}{N-1}\sum(R_i - \overline{R_i})(R_m - \overline{R_m})$$

$$Var(R_m) = \frac{1}{N-1}\sum(R_m - \overline{R_m})^2.$$

Where $E(R_i)$ is the expected returns on the asset i, R_f is the risk-free rate, $E(R_m)$ is the expected returns on the market portfolio, β_i is the beta of asset i (a measure of risk), $Cov(R_i, R_m)$ is the covariance of returns on asset i and market portfolio $m, Var(R_m)$ is the variance of returns on market portfolio, R_i is the returns on asset i, R_m is the returns on market portfolio, $\overline{R_i}$ is the mean of returns on asset i, $\overline{R_m}$ is the mean of returns on market portfolio, N is the number of observations (considered in years). Thus, as long as the parameters listed are estimated, it is trivial to determine the expected returns of any investment. For the purpose of this paper, three assets are considered for the estimation of the parameters. The model (2) can be written in a compact form as

$$Expected\ Return = Risk\ free\ rate + Risk\ premium. \qquad (3)$$

The first half of (3) represent risk-free return (R_f) that compensate investors for placing money in any investment over a period of time. The other half of the model (CAPM) represents risk premium ($\beta_i[E(R_m) - R_f]$) for bearing additional risk. The assumption of the model (2) means that all investors:

1. Aim to maximize economic utilities of their wealth
2. Are rational and risk-averse
3. Are broadly diversified across a range of investments
4. Are price takers, i.e. they cannot influence prices
5. Can lend and borrow unlimited amounts under the risk-free rate of interest
6. Trade without market imperfections such as taxes, regulations or transaction costs
7. Have negligible restrictions on investment and no investors is large enough to affect the market price of the stock
8. Asset market prices are frictionless. Information is costless and simultaneously available to all investors
9. Quantities of securities (or assets) are fixed. Also, all securities (or assets) are marketable and perfectly divisible [25].

Remark 1: The model (2) assumes that the standard deviation of past returns is a proxy for the future risk associated with a given asset. Most of these assumptions imply that there exist perfect markets.

4. Data Analysis

This section analyzes the Precious metals and crude oil data obtained from Yahoo Finance DataStream. Considering, three assets of the Precious metals and crude oil investments: Franklin Gold and Precious Metal (FGPM), Deutsche Gold and Precious Metals (DGPM), Invesco Gold and Precious Metals (IGPM) from 2012 to 2016. The effects of risk (β) on the expected returns for each asset are hereby considered. In Table 1, R_f is Risk-free rate, RFGPM is Returns on Franklin Gold and Precious Metal, RDGPM is Returns on Deutsche Gold and Precious Metals, RIGPM is Returns on Invesco Gold and Precious Metals, R_m is Returns on market portfolio. After the analysis of the data, results in Table 2 were divulged.

Table 1. *Data for RFGPM, RDGPM, RIGPM, Market returns (R_m) and the Risk-free returns (R_f).*

YEAR	RFGPM	RDGPM	RIGPM	R_m	R_f
2012	0.1002	0.0434	0.0242	0.0559	1.3820
2013	0.6047	0.2707	0.1588	0.3447	1.6090
2014	0.5329	0.2192	0.1372	0.2964	1.4340
2015	0.3937	0.1584	0.1034	0.2185	2.1610
2016	0.5525	0.2129	0.1378	0.3011	2.1680
MEAN	0.4368	0.1809	0.1123	0.2433	1.7508

Table 2. *Numerical Results for FGPM, DGPM and IGPM assets.*

ASSETS	β	$\beta\%$	$E(R)$	$E(R)\%$
FGPM	1.7817	0.5939	0.4301	0.5892
DGPM	0.7535	0.2512	0.1844	0.2527
IGPM	0.4648	0.1549	0.1154	0.1581

Figure 2. *Expected returns* $E(R)$ *against the risk* (β) *for the three assets.*

Implication of results: As indicated in the Tables 2 and 3, and the Figure 2 presented, FGPM yielded expected return $E(R)$ of 0.4301 with the highest risk (β) 1.7817. This implies that the organization should invest only 59% of her wealth in risky asset and 41% in the risk-free asset. Furthermore, DGPM divulged $E(R)$ of 0.1844 with the risk of 0.2512. This means that 25% of the organization's wealth should be invested in risky asset while 75% in the risk-free asset. Finally, the IGPM yielded the minimum $E(R)$ of 0.1154 with the least risk of 0.1581. This also indicates that the organization should invest 15% of her wealth in risky asset and 85% in the risk-free asset.

5. Conclusion

The CAPM is used in this paper to determine the effects of the expected returns on the risk associated with the investments of the Precious metals and crude oil. Moreover, it also established the percentage of the organization's wealth to be invested in risky and in risk-free assets without sacrificing returns. Before engaging in financial investments, it is expedient that such organization or individual use CAPM as an effective pricing tool to examine the possible returns and the risk associated with such investment. It is, therefore, recommended that the use of CAPM to portfolio managers for accurate estimation of cost capital; evaluation of performance for managed portfolios; and possible predictions for future investments should be taken into consideration. This study has revealed that the lower the beta - β (risk) the lower the expected returns and the higher the beta - β the higher the expected returns for the data considered.

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