Effects of Correlation on Diversification of Precious Metals and Oil

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Abstract

Studies on portfolio diversification shows that, well diversified portfolios minimize risk of the portfolio. Correlation measures the degree at which two variables move together. It determines the values of risk of the portfolio. This paper investigates the correlations between precious metals and oil and also estimates the risk associated with the correlated assets and finally checked the upward or downward trend of the precious metals and oil. We obtain three main results from the research. First, investing in gold will serve as hedge during financial crisis. Second, decision on the assets to diversify on, should not only be based on the results of correlation coefficients but also include the results of risk associated with the correlated assets. Third, currency use in the trading of assets determines the upward and downward trends of those assets.

Keywords: Diversification, Correlation, Precious metals, oil

1 Introduction

Diversification is investing in various assets in order to reduce risk of the portfolio. It is a means by which investors grow from his mini-firm into other market
products [1]. Many researchers have shown that gold is low correlated, even negatively correlated with many traditional assets, which means adding it to investment portfolio will diversify away risk.

Asset is diversifiable if it is not perfectly correlated with the market and a hedge if it is on average uncorrelated or negatively correlated with the other assets. It will be a safe haven if it is uncorrelated or negatively correlated with the market. [2]

The commodities are diversifiable asset classes if there are negatively correlated with other asset classes. These features of asset could motivate investors to invest on diversifiable assets as a hedge in the period of stress.

The precious metals’ (gold, silver and platinum) returns are low correlated with stock returns which indicate their ability as a diversifiable asset and hedging strength. They also discovered that precious metals are capable of strengthening portfolio efficiency in terms of reward to risk in crises time [3] and [4]. The precious metals give similar or improve investment prospects during the market turmoil and affirm that silver and platinum give investor’s better reward for their losses than gold [5]. In addition, the precious metals markets are less distorted during global financial crisis unlike other financial market around them [6].

Gold and silver protect investors’ prospects against downward condition of stock markets [7] and [8].

The objective of this study is to examine the correlations of precious metals and oil, and affirm the best diversifiable assets. The remainder of the paper proceeds as follows, section two presents the Literature Review, section three shows the models and methods, section four describes the data and section five discusses the research findings and section six concludes.

2 Literature Review

In Markowitz discovery, he pointed out that the proper risk encountering by an investor was portfolio risk which leads to a basic and important point that the risk of a stock should not only be estimated just by the variance of the stock but also by their covariance. Also, part of his observations is that, best portfolio should consist of assets that are perfectly negatively correlated. [11], [12]

The Markowitz stock portfolio is modelled, by minimizing the risk of the portfolio as estimated by the variance of stock prices subject to a given portfolio return. The model is capable of estimating optimal weight of stock in the portfolio.

The equation of returns on security $i$ discovered by Markowitz to explain the fluctuations of security returns with a general market index, $p$. He concluded that market model was as complex as covariance and very useful [13]. This was supported by [14]. Strong evidence for industry factors in collaboration with market wide factor was discovered by [15].

The diversification characteristics of precious metals have caught the attention of many investors. There are indications that gold is low correlated with traditional financial assets (stocks) and this makes it to have a profitable diversifi-
cations effects [18]. Moreover, further empirical confirmation that precious metals (gold, silver and platinum) give vital diversification rewards in broad investment portfolios, as their outcomes affirm the low correlation amongst precious metals and stock markets. The outcomes of these researches affirmatively forecast that diversifying in gold or in general; precious metals may give the same diversification rewards for diversifying in international assets [3].

The correlation of price of oil and precious metals is a complex issue. According to economic value, oil is the most transacted asset amongst the assets and the price is very unstable. Also precious metals are transacted for dual purposes; as hedging strategies and for industrial use. The oil price is unstable than gold and silver as affirmed by [20]. The precious metals show a high pass through, meaning that they have high response to crude oil price and a strong correlation between oil and gold with an unidirectional causality of gold and oil [21].

3 Models and Method

This section outline Dynamic conditional correlation and Estimators models used to model correlation. Conditional correlation, $\rho_{1,2,t}$ between two random variables $\gamma_1$ and $\gamma_2$ where each has mean zero is defined as:

$$\rho_{1,2,t} = \frac{E_{t-1}(\gamma_{1,t}\gamma_{2,t})}{\sqrt{E_{t-1}(\gamma_{1,t}^2)E_{t-1}(\gamma_{2,t}^2)}}$$  \hspace{1cm} (1)

Where $E_{t-1}$ is the estimator of random variables. The conditional correlation depends solely on previous period information with $-1 \leq \rho_{1,2,t} \leq 1$. To simplify the relationship between conditional correlations and conditional variances, the returns are written as the conditional standard deviation times the standardized distribution:

$$h_{i,t} = E_{t-1}(\gamma_{i,t}^2)$$

$$\gamma_{i,t} = \sqrt{h_{i,t}}e_{i,t}, \hspace{1cm} i = 1, 2, \ldots$$  \hspace{1cm} (2)

$e$ is a standardized disturbance that has mean zero and variance one for each series. Now, substituting in equation (1) becomes

$$\rho_{1,2,t} = \frac{E_{t-1}(e_{1,t}e_{2,t})}{\sqrt{E_{t-1}(e_{1,t}^2)E_{t-1}(e_{2,t}^2)}} = E_{t-1}(e_{1,t}e_{2,t})$$  \hspace{1cm} (3)

The conditional correlation is the same as conditional covariance between the standardized disturbances. The correlation estimator is defined for returns with a mean of zero as:
\[ \rho_{12,t} = \frac{\sum_{s=t-n}^{t-1} \gamma_{1,s} \gamma_{2,s}}{\sqrt{\left( \sum_{s=t-n}^{t-1} \gamma_{1,s}^2 \right) \left( \sum_{s=t-n}^{t-1} \gamma_{2,s}^2 \right)}} \] (4)

It gives equal weight to all observations less than \( n \) periods in the past and zero weight on older observations. The estimator lies within the interval \([-1, 1]\).

The exponential smoother, that is Risk metrics make use of declining weights depending on parameter \( \lambda \).

\[ \rho_{12,t} = \frac{\sum_{j=1}^{t-1} \lambda^{t-j-1} \gamma_{1,s} \gamma_{2,s}}{\sqrt{\left( \sum_{j=1}^{t-1} \lambda^{t-j-1} \gamma_{1,s}^2 \right) \left( \sum_{j=1}^{t-1} \lambda^{t-j-1} \gamma_{2,s}^2 \right)}} \] (5)

In multivariate context, to ensure positive correlation matrix, the same \( \lambda \) must be used for all assets. Conditional covariance matrix returns is defined as:

\[ E_{t-1}(\gamma, \gamma') = H_t \] (6)

This estimator can be represented in matrix form respectively as:

\[ H_t = \frac{1}{n} \sum_{j=1}^{n} (\gamma_{t-j} \gamma'_{t-j}) \quad \text{and} \]

\[ H_t = \lambda (\gamma_{t-1} \gamma'_{t-1}) + (1-\lambda)H_{t-1} \] (7)

To specifically solve \( A \), such that

\[ y_t = A \gamma \]

\[ E(y_t, y'_t) \equiv V \quad \text{is diagonal} \]

Taking the assumption that

\[ E_{t-1}(y_t, y'_t) = V_t \quad \text{then} \]

\[ H_t = A^{-1}V_t A^{-1} \] (8)

In bivariate, the matrix \( A \) can be selected to be triangular and calculated by least squares where \( \gamma_1 \) is one component and residuals from a regression of \( \gamma_1 \) and \( \gamma_2 \) are the second. In this case, it is better to run the regression as Garch regressions in order to obtain the residual that are orthogonal in a generalized least square (GLS) metric. [23] Described the expression of this type, called vec model. The vec model parameterizes the vector of all covariances and variances stated as \( vec (H_t) \). In the first order, it is given as:
Effects of correlation on diversification of precious metals and oil

\[ \text{vec}(H_t) = \text{vec}(\Omega) + A \text{vec}(\gamma_{t-1}'\gamma_{t-1}') + B \text{vec}(H_{t-1}) \]  
(9)

Where \( \alpha \) and \( \beta \) are \( n^2 \times n^2 \) matrices with structure following from the symmetry of \( H \). The restrictions are obtained from the \( BEKK \) representation and can be expressed as:

\[ H_t = \Omega + A(\gamma_{t-1}'\gamma_{t-1}')A' + BH_{t-1}B' \]  
(10)

In general, vec model of equation 9 can be expressed as:

\[ \text{vec}(\Omega) = (1 - A - B)\text{vec}(s) \]

Where \( S = \frac{1}{T} \sum_i (\gamma_i, \gamma_i') \)  
(11)

This expression simplifies in the scalar and diagonal \( BEKK \) cases. For the scalar \( BEKK \), the intercept is:

\[ \Omega = (1 - \alpha - \beta)S \]  
(12)

[24] Viewed constant conditional correlation estimator as

\[ H_t = D_tRD_t \]

Where \( D_t = \text{diag}\{h_{t,i}\} \)  
(13)

Where \( R \) is a correlation matrix containing the conditional correlations

\( E_{t-1}(\varepsilon_t, \varepsilon_t') = D_t^{-1}H_tD_t^{-1} = R \)

Since \( \varepsilon_t = D_t^{-1}\gamma_t \)  
(14)

The expressions for \( h \) are based on univariate Garch models. Estimate of \( R \) is the unconditional correlation matrix of the standardized residuals.

The dynamic correlation model varies only in allowing \( R \) to be time varying:

\[ H_t = D_tRD_t \]

(15)

The matrix \( R_t \) remains the correlation matrix. The easiest specification for the correlation matrix is the exponential smoother which can be expressed as:

\[ \rho_{i,j,t} = \frac{\sum_{s=1}^{t-1} \lambda^s e_{i,t-s}e_{j,t-s}}{\left(\sum_{s=1}^{t-1} \lambda^s e_{i,t-s}^2\right)^{\frac{1}{2}} \left(\sum_{s=1}^{t-1} \lambda^s e_{j,t-s}^2\right)^{\frac{1}{2}}} = [R_t]_{i,j} \]  
(16)

A geometrically weighted average of standardized residuals. Obviously these equations will produce a correlation matrix at each point in time. The construction of this correlation is through exponential smoothing.
4 Data

The sample data consists of daily closing spot prices for gold, silver, platinum, palladium and oil from S&P 500 span through 16th August, 2006 to 2nd January, 2015.

5 Research Findings and Discussions

Table 1: The Correlations matrix of prices

<table>
<thead>
<tr>
<th></th>
<th>Gold</th>
<th>Silver</th>
<th>Platinum</th>
<th>Palladium</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>-0.0812</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td>-0.6980</td>
<td>0.4627</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palladium</td>
<td>-0.5209</td>
<td>0.7336</td>
<td>0.8531</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>-0.5625</td>
<td>0.5010</td>
<td>0.4227</td>
<td>0.4975</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1 provides the correlation matrix of all assets (Gold, Silver, Platinum, Palladium and Oil). One of the objectives of this paper is to estimate the correlations of the assets and see those assets that are diversifiable. Diversifiable assets are determined by low correlation values. It can be vividly seen that correlation of Gold and Platinum has the lowest value of (-0.6980) followed by Oil and Gold with (-0.5625). But to conclude on the assets that would give the best diversification we need to estimate the risk associated with diversifiable assets. To estimate the risk, we shall adopt the method of Harry Markowitz.

\[
\delta_p^2 = w_1^2 \delta_1^2 + w_2^2 \delta_2^2 + 2w_1w_2 \rho_{12} \delta_1 \delta_2
\]

(18)

\[
\delta_p = \sqrt{\delta_p^2}
\]

where \( \delta_p^2 \) and \( \delta_p \) are variance and standard deviation of the portfolio return respectively, \( w_1, w_2 \) are the weights of assets 1 and 2 in the portfolio, \( \delta_1^2, \delta_2^2 \) are the variances of the returns on assets 1 and 2, \( \rho_{12} \delta_1 \delta_2 \) is the covariance of the returns on assets 1 and 2.

Table 2: Results of Risk of the Assets

<table>
<thead>
<tr>
<th>Risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold and Silver</td>
</tr>
<tr>
<td>Gold and Platinum</td>
</tr>
<tr>
<td>Gold and Palladium</td>
</tr>
<tr>
<td>Gold and Oil</td>
</tr>
</tbody>
</table>
Using equation 18 the values in table 2 were divulged.

Figures 1 to 5 are the charts of daily closing spot prices of Gold, Silver, Platinum, Palladium and Oil from August 2006 to January 2015. The charts exhibit downward trends in returns predictability. Commodities are influenced by common macroeconomics factors such as interest rate, exchange rate and inflation [25].
6 Conclusions

This paper investigates correlation between precious metals and oil, and also estimates risk associated with the negatively correlated assets, means of deciding for best diversification of assets. The research reveals that, Gold is negatively correlated with all the other assets; Silver, Platinum, Palladium and Oil, it means investing on Gold will serve as hedge during crisis. It was discovered that diversification of gold and oil exhibit the lowest value of risk followed by gold and platinum, it shows that investing in Gold and Oil would reduce risk of portfolio, though needful to say that investing in other negatively correlated assets would yield good result but the best diversifiable assets is gold and oil. From the charts, Precious metals and Oil experience downward trends in their returns lately. This is as a result of the fall in the currency (dollar). This shows that dollar exchange rate has great influence on these assets (Gold, Silver, Platinum, Palladium and Oil). This implies, the currency use in the trading of assets determines the upward and downward trends of those assets.

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