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GOLD AS PART OF AN INVESTMENT PORTFOLIO

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Abstract:
The goal of the article is to assess the role of gold as a component of the investment portfolio. The constructed two-component portfolios were assessed: minimum variance portfolios and optimal portfolios. Every portfolio contains gold combined with one of the three classes of assets: stocks, commodities/raw materials, and real estate represented by the S&P500 stock index, the TR/J CRB Index, and the WILREIT Index respectively. Minimum variance portfolios were constructed according to the two-asset portfolio theory, and optimal portfolios – using the Sharpe ratio. Minimum variance portfolios contain different percentages of gold, i.e. ranging from 49.0% (TR/J CRB Index and gold) to 64.0% (WILREIT Index and gold). The diversification effect as an increase in the expected rate of return with the simultaneous reduction of risk level occurs only in the case of the portfolio (TR/J CRB Index and gold). Optimal portfolios are characterized by the following percentage of gold: the TR/J CRB Index and gold (100.0%), S&P500 Index and gold (34.0%), WILREIT Index and gold (0.0%). The first is a one-component portfolio, in which gold is a "perfect" substitute for investments in commodities. The last one is also a one-component portfolio containing real estate only. The original character of investigations consists in attempting to find an answer to the question: what is the role of gold as a component of investment portfolios in the periods of uncertainty in many asset markets?

Keywords: *finance*, *diversification, gold portfolio, minimum variance portfolio, optimal portfolio, correlation coefficient, Sharpe ratio*

1. INTRODUCTION

Most investors have an aversion to risk and, consequently, seek opportunities to protect their investment portfolios against losses. There are nominal guarantees understood as a portfolio's risk reduction *(Volatility*) and real guarantees, or the protection of nominal rates of return against inflation and thereby against real negative rates. In the former case one of the possibilities of risk reduction is the diversification of the portfolio[1], consisting in the inclusion of new asset classes in its composition (Stopfer, 2006, p. 131). Gold as a financial instrument can be a significant component of any investor's portfolio. Studies by many authors (Ghosh et al., 2004; Mani & Vuyyuri, 2005; Demidova-Menzel, Heidorn, 2007; Jaffe, 1989] point to the role of gold as an important instrument of the portfolio's diversification because of the negative or minimally positive correlation of its price with many classes of assets. Portfolios containing gold are characterized by smaller volatility and show higher rates of return [Chua et al., 1990; Ciner, 2001].

The goal of the paper is to assess the role of gold as a component of the investment portfolio. The constructed two-component portfolios were assessed: minimum variance portfolios and optimal portfolios. Every portfolio contains gold combined with one of the three classes of assets: a) stocks represented by the S&P500 Index, b) commodities represented by the TR/J CRB Index, and c) real estate represented by the WILREIT Index.

The analysis covers a twenty-year period (from 1994 to 2013). This is a special period in the evolution of gold prices, which embraces the continuation of stagnation in this market, lasting until April 2001, the unprecedented bull market until early September 2011(on 2 April 2001 the lowest price of gold was recorded at 255.95 USD/oz, and on 6 September 2011 the highest price at 1895.0 USD/oz, an increase by 640.38%), and apparently the first years of the present decline.

The structure of the article is as follows: Section 1 characterizes the sources of data and methodology. Section 2 presents the basic characteristics of the portfolio components. Section 3 contains the empirical analysis of the constructed portfolios. Section 4 contains discussion and conclusions.

2. SOURCES OF DATA AND METHODOLOGY

Calculations were made based on historical daily gold prices according to London Afternoon (PM) Gold Fix quotations and the values of the S&P 500 stock index, TR/J CRB commodity index, and the WILREIT real estate index, as well as the rates of return of 20-year US bonds. Based on this data, nominal annual rates of return of these asset classes were calculated, as well as basic characteristics of an asset class: the expected rate of return, standard deviation, and the correlation coefficient between gold and this asset were computed. On the basis of these characteristics, in accordance with the two-asset theory, the minimum variance investment portfolio was constructed. At the next stage, the annual average rate of return on investment in 20-year US bonds was calculated, adopted as a risk-free rate, and then the Sharpe ratio was computed. Finally, using the Sharpe ratio, the optimal portfolio was constructed. These portfolios are shown on the chart: the risk/return map. This method was utilized in the case of each of the analyzed portfolios. In the Conclusions Section a comparative analysis of the optimal portfolios was carried out.

The basic characteristics of assets, necessary for the construction of portfolios (the expected rate of return of the portfolio, standard deviation of rates of return, and Sharpe ratio) were calculated using the following formulas:

[1] The issues of portfolio diversification have been known since the ancient times. Greek philosopher Epictetus (50 – 125 CE) formulated the now widely known stock exchange wisdom: "do not put all eggs in one basket" (Nauckhoff, 2011, p. 75).

$$E(R_p) = w \times E(R_G) + (1-w) \times E(R_C)$$

$$\sigma_p = \sqrt{w^2\sigma_G^2 + (1-w)^2\sigma_C^2 + 2w(1-w)\sigma_G\sigma_C\rho_{GC}}$$

$$S_p = \frac{E(R_p) - R_f}{\sigma_p},$$

where:

$E(R_p)$ - expected rate of return on a portfolio,

σ_p - standard deviation of a portfolio's rate of return,

S_p - Sharpe ratio,

$E(R_G)$ - expected rate of return on investment in gold,

$E(R_C)$ - expected rate of return on investment in the other component of the portfolio,

σ_G - standard deviation of the rate of return on investment in gold,

σ_C - standard deviation of the rate of return on investment in the other component of the portfolio,

ρ_{GC} - correlation coefficient of rates of return on investment in gold and in the other component of the portfolio,

w - percentage of gold in the portfolio.

To an investor who is guided by the principle of obtaining the highest expected rate of return with the lowest risk possible, the so-called effective portfolios are attractive. An effective portfolio is one that: a) minimizes risk (standard deviation) for an expected rate of return of the portfolio (but higher than the expected rate of return of the minimum variance portfolio); b) maximizes the expected rate of return for a given risk (standard deviation). One of effective portfolios is also the *Minimum Variance Portfolio*, (MVP). Other portfolios are dominated by effective portfolios. The optimal portfolio is characterized by the highest Sharpe ratio. This ratio determines the amount of risk premium (measured by the difference between the rate of return on the portfolio and the risk-free rate) per unit of total risk (measured by the standard deviation for the rate of return of the portfolio). The expected rate of return and risk of the portfolio depends not only on the level of the characteristics of its individual components but also on the correlation coefficients of the rates of return for these components. In order to achieve a diversification effect as an increase in the expected rate of return with a simultaneous risk reduction, investors who have an aversion to risk include in the portfolio the classes of assets that exhibit a negative or small positive correlation with others (Markowitz, 1952, pp. 77-91)

3. BASIC CHARACTERISTICS OF THE COMPONENTS OF THE ANALYZED INVESTMENT PORTFOLIOS

In order to construct the analyzed portfolios the characteristics of assets that are their components were calculated based on reference data (Table 1).

Table 1: Characteristics of selected assets in 1994 – 2013

Assets	Expected rate of return (annual)	Standard deviation	Correlation coefficient with gold
Gold	5.81%	15.84%	1.00
S&P500 Index	8.34%	18.48%	-0.22
TR/J CRB Index	1.67%	15.74%	0.52
WILREIT Index	12.36%	20.59%	0.11
20-year US bonds	5.17%	1.33%	-0.18

Source: own calculations based on Yahoo Finance

It follows from Table 1 that particular assets are characterized by diversified expected rates of return while the risk levels measured by the standard deviation of rates of return are similar. Gold exhibits a higher expected rate of return and standard deviation (slight) only in comparison with the TR/J CRB Index: (5.81% *versus* 1.67%) and (15.84% *versus* 15.74%) respectively, and at the same time a higher (better) relation between the expected rate of return and risk (0.367 *versus* 0.106). In the remaining cases the rate is worse: (0.367 *versus* 0.652) for the S&P500 Index, and (0.367 *versus* 0.618) for the WILREIT Index. Correlation coefficients of gold with particular asset classes assume both positive values: 0.11 (WILREIT Index) and 0.52 (TR/J CRB Index), and negative values: -0.22 (S&P500 Index). Gold, characterized by comparatively low correlation coefficients with the analyzed classes of assets, should be taken into consideration as an important component of the portfolio. The annual average rate of return on investment in 20-year US bonds, which was adopted as a risk-free rate (r_f), is 5.17%.

4. GOLD AS A COMPONENT OF PORTFOLIOS

4.1. Portfolio: S&P500 Index and gold

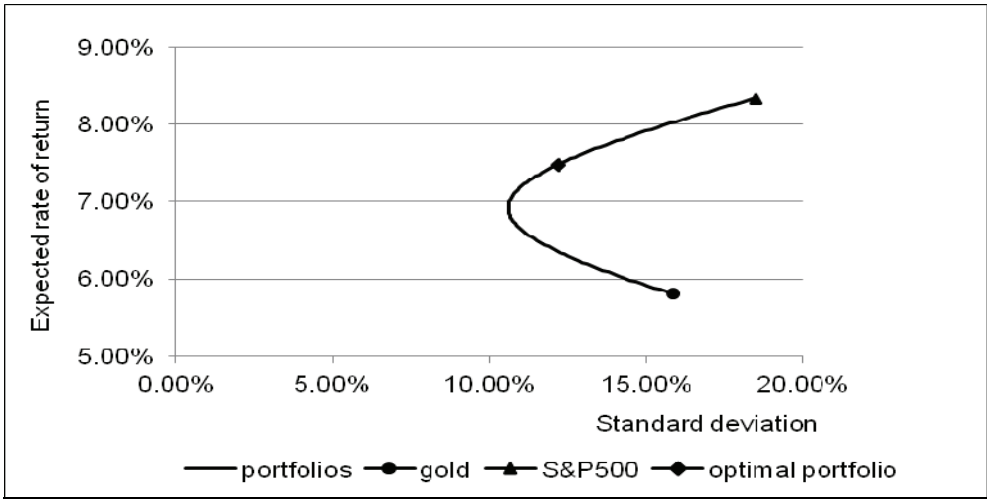
One of the well-known stock indexes is the S&P500 Index. It contains the stocks of industrial, commercial, transport and financial sector companies. The result of portfolio diversification by taking the gold component into consideration is illustrated in Table 1 and Figure 1.

Table 2: Portfolios: S&P500 Index and gold

Portfolio	Expected rate of return (annual)	Standard deviation	Percentage of gold
S&P500 Index	8.34%	18.48%	0.0%
Minimum variance portfolio	6.92%	10.62%	56.0%
Optimal portfolio	7.48%	12.19%	34.0%

Source: own calculations based on Yahoo Finance

Figure 1: Portfolios: S&P500 Index and gold (ρ = - 0.22)



Source: own calculations based as in Table 2.

The expected rate of return on investment in the S&P500 Index was 8.34% with the standard deviation at 18.48%. The inclusion of gold at 56.0% reduced the portfolio risk to the level of 10.62%, i.e. by as much as 7.86 percentage points. However, this resulted in a decrease in the expected rate of return to the level of 6.92%, or by 1.42 percentage points. In this way, a minimum variance portfolio was built. Portfolios with higher percentages of gold, i.e. up to 100.0% inclusive, are ineffective portfolios. The optimum solution is the portfolio with the highest Sharpe ratio (S_p=0.189), with the percentage of gold at 34.0%. This is the dominant portfolio characterized by a higher rate of return (7.48%) and higher risk (12.19%) than the minimum variance portfolio. An investor with an aversion to risk will be ready to take into account the percentage of gold at 34.0% in the portfolio because he will achieve

a significant risk reduction (by 6.29 percentage points) with a slight drop of the expected rate of return (by 0.86 percentage points) as compared with a one-component portfolio. The optimal portfolio: the S&P500 Index and gold is thereby characterized by a significantly lower range of the rate of return variability than the one-component portfolio containing only stocks (-4.71% to 19.67% *versus* -10.14 do 26.82).

4.2. Portfolio: The Thomson Reuters/Jefferies Commodity Research Bureau Index and gold

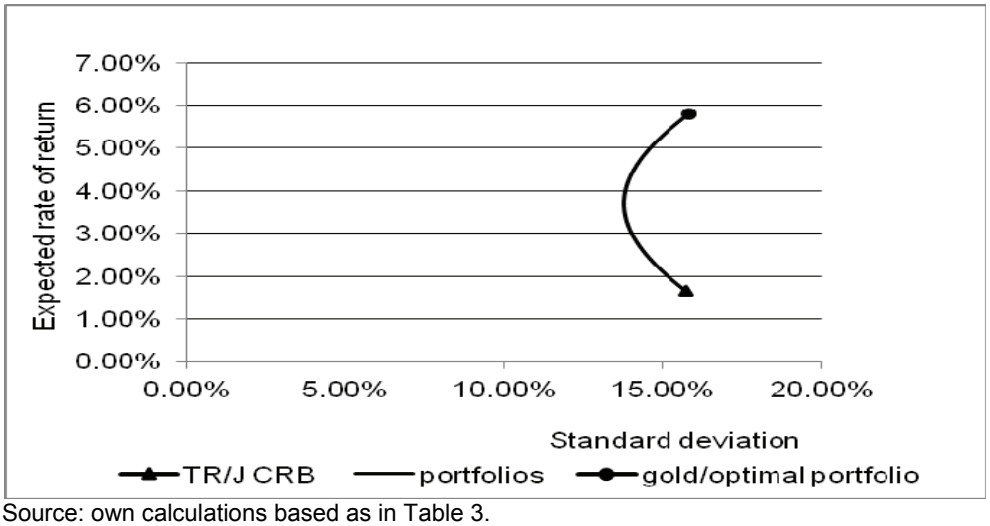
There are many indexes in raw material and commodity markets. The oldest, published since 1957, was the *Commodity Research Bureau Index* (CRB), which, after subsequent revisions, took on the present name *The Thomson Reuters/Jefferies CRB Index* (TR/J CRB). The TR/J CRB Index reflects changes of the prices in the futures basket for 19 raw materials and commodities, presented in four groups. The highest percentage in the basket is that of petroleum products (33%), soft commodities (21%), industrial metals (13%) and grains (13%)[2]. The correlation coefficient of rates of return for the TR/J CRB Index and gold is comparatively high (ρ=0.52) as compared with the other coefficients. The argument for gold as a component of the portfolio is, however, the far higher (better) relation between the expected rate of return and risk in the case of gold than the TR/J CRB Index (0.367 *versus* 0.106). The illustration of the portfolio diversification is shown in Table 3 and Figure 2.

Table 3: Portfolios: TR/J CRB Index and gold

Portfolio	Expected rate of return (annual)	Standard deviation	Percentage of gold
The TR/J CRB Index	1.67%	15.74%	0.0%
Minimum variance portfolio	3.70%	13.78%	49.0%
Optimal portfolio	5.81%	15.84%	100.0%

Source: own calculations based on YCHARTS

Figure 2: Portfolios: TR/J CRB Index and gold (ρ = 0.52)



Source: own calculations based as in Table 3.

The expected rate of return on investment in raw materials (commodities) (TR/J CRB Index) is 1.67% with the standard deviation at 15.74%. Investment in this market is thus characterized by a high risk.

[2] Analysis of changes in the TR/J CRB Index can, because of the raw materials and commodities represented in it, be a good illustration of the course of cycles in the raw materials markets. According to this theory, in the raw materials market there are specific stages characterized by both considerable rises and drops of the prices of basic industrial raw materials. Unlike in stock markets these periods of boom and slump in this market historically stretch, however, to far longer periods in a tendency for a super-cycle that may last for many decades. At the same time there is a high positive correlation between changes of raw materials/commodities prices and the change of gold prices (Schwarze, 2011, p. 214).

The percentage of gold at 49.0% reduces the portfolio's risk to the level of 13.78%, or by 1.96 percentage points, with a simultaneous increase in the expected rate of return to 3.70%, or by 2.03% percentage points. An investor obtains a far higher rate of return with a simultaneous lower risk as compared with the one-component portfolio. This is a minimum variance portfolio. Portfolios built through successive increases in the percentage of gold up to 100.0% inclusive are effective portfolios dominating over the others. The optimum solution is the one-component portfolio with the percentage of gold at 100.0%, the expected rate of return at 5.81%, and the standard deviation at 15.84%, as well as characterized by the highest Sharpe ratio (S_p=0.040). The component of such a portfolio is gold only. Complement of the one-component portfolio (of TR/J CRB Index with gold) up to 100.0% increases its risk only by 0.1 of the percentage point (15.84%–15.74%), while it results in an increase in the expected rate of return by as much as 4.14 percentage points (5.81%–1.67%). It is therefore the dominant portfolio with a far higher rate of return and a negligibly higher risk than the univariate portfolio. With almost the same risk, investors achieve a much higher rate of return. The optimal portfolio, or one-component portfolio with gold only, is also characterized by almost the same range of rate of return volatility as the one-component portfolio containing only raw material commodities (-0.03% to 21.65% *versus* -14.07 do 17.41). In other words, investors should not invest capital in commodities represented by the TR/J CRB Index, but should invest all capital in gold.

4.3. Portfolio: The US Wilshire REIT Index and gold

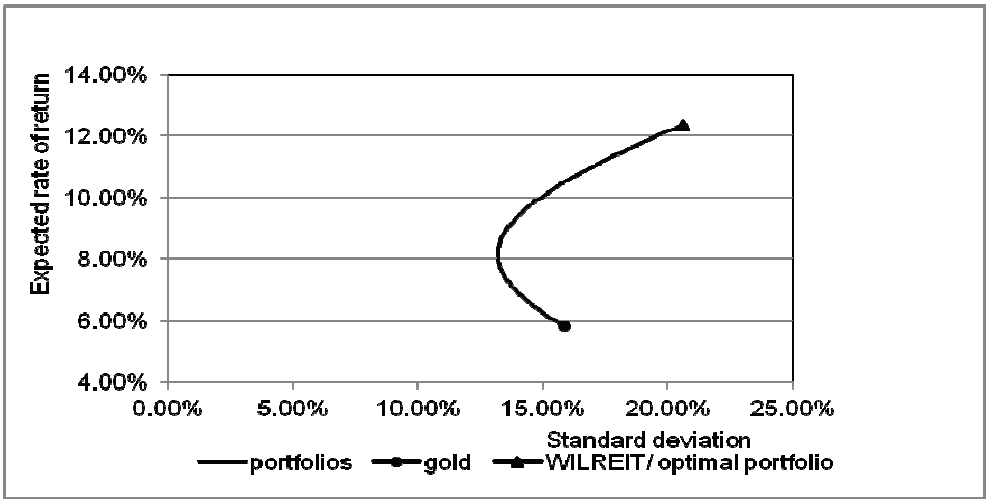
The component of the investment portfolio can be real estate. These assets comprise direct investment in real estate (property investments) and investments in financial instruments of the real estate market. In order to take into consideration this class of assets in the investment portfolio the US Wilshire REIT Index (WILREIT) was applied. This index has been published since 1 January 1978. It reflects changes in prices of shares in investment funds (Real Estate Investment Trust, REIT) that invest directly or indirectly in real estate: purchase of stocks or shares of companies whose property includes real estate (Wilshire Associates). The correlation coefficient of the asset classes in question (ρ=0.11) is positive yet small. The result of the portfolio diversification is illustrated in Table 4 and Figure 3.

Table 4: Portfolios: WILREIT Index and gold

Portfolio	Expected rate of return (annual)	Standard deviation	Percentage of gold
WILREIT Index	12.36%	20.59%	0.0%
Minimum variance portfolio	8.17%	13.21%	64.0%
Optimal portfolio	12.36%	20.59%	0.0%

Source: own calculations based on Wilshire Associates ; Yahoo Finance

Figure 3: Portfolios: WILREIT Index and gold (ρ = 0.11)



Source: own calculations based as in Table 4.

The expected rate of return on investment in the WILREIT Index is 12.36% with the standard deviation at 20.59%. The inclusion of gold in the portfolio at 64.0% reduces its risk to the level of 13.21%, or by as much as 7.38 percentage points. However, this results in a decrease in the expected rate of return to the level of 8.17%, or by 4.19 percentage points. In this way the minimum variance portfolio is constructed. An investor with an aversion to risk will be willing to accept the percentage of gold in the portfolio at the amount of 64.0% because with a far lower risk he will obtain a comparatively high rate of return as compared with the one-component portfolio. The optimal solution is the portfolio with the highest Sharpe ratio (S_p=0.34), with the percentage of gold at 0.0%, with the expected rate of return equaling 12.36%, and with the risk equaling 20.59%. It is thus a one-component portfolio containing real estate only. A risk-prone investor will not combine gold with real estate because by investing in real estate only, he obtains a 2.13 times higher rate of return, with the risk rising only by 4.75 percentage points. The optimal, or one-component, portfolio containing only real estate, i.e. without the gold component, is characterized by a comparatively large range of the rate of return variability: -8.23% to 32.95%.

5. DISCUSSION AND CONCLUSIONS

In this paper the assessment of the role of gold as a component of the constructed two-asset investment portfolios: minimum variance and optimal ones was carried out. Every portfolio contained gold combined with one of the three classes of assets: stocks, commodities/raw materials, and real estate represented by the S&P500 stock index, the TR/J CRB index, and the WILREIT index respectively. The present discussion shows that the expected rate of return and risk of the investment portfolio were determined by the level of basic characteristics of its components: expected rate of return, risk (measured by standard deviation), percentage of each component in portfolio, and the correlation coefficient between prices of gold and other mentioned assets. The level of risk and risk premium gave rise to specified rankings of the constructed investment portfolios. When constructing specific portfolios with a percentage of gold, investors present on the particular market should take into consideration the objective of a particular investment and their risk proneness.

Portfolios with the lowest minimum variance, in ascending order, were the portfolios: S&P500 Index and gold (σ=10.62%), WILREIT Index and gold (σ=13.21%), TR/J CRB Index and gold (σ=13.78%). They contained different percentages of gold, i.e. ranging from 49.0% (portfolio: TR/J CRB Index and gold) to 64.0% (portfolio: WILREIT and gold). The diversification effect as an increase in the expected rate of return with a simultaneous risk reduction in comparison with the one-component portfolio occurred only when gold was included in one portfolio (TR/J CRB Index and gold). In the other cases risk averse investors will also consider gold as a portfolio component as in spite of lowering of the expected rate of return they will achieve significant risk reduction.

From the perspective of the most advantageous relation between risk premium and total risk, measured with the Sharpe ratio, the following ranking of optimal portfolios can be made: the WILREIT Index and gold (Sp=0.349), the S&P500 Index and gold (Sp=0.189), and the TR/J CRB Index and gold (Sp=0.040). They are characterized by different percentages of gold, and they can be arranged in descending order as follows: the TR/J CRB Index and gold (100.0%), the S&P500 Index and gold (34.0%), and the WILREIT Index and gold (0.0%). Two optimal portfolios were therefore one-component portfolios with extreme percentages of gold.

The risk-prone investors will prefer optimal portfolios with the highest range of rate of return variability. These portfolios were classified, starting from the highest, as follows: the WILREIT Index and gold (-8.23% to 32.95%), the TR/J CRB Index and gold (-10.03% to 21.65%), and the S&P500 Index and gold (-4.71% to 19.67%).

The assessment of the obtained results should take account of the fact that the analysis covers a special 20-year period of the development of the gold market, in which an unprecedented ten-year boom occurred, followed by a sharp decline in its price.

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