Eldin Dobardzic[1], Biljana Rakic[2]

INTERDEPENDENCE BETWEEN STOCK MARKET INDEX S&P 500 AND GOLD DURING THE FINANCIAL CRISIS AS THE BASE FOR MACROECONOMIC POLICY DECISIONS

This paper investigates the interdependence between spot daily gold and stock market index S&P 500 price returns during the financial crisis in 3 estimation periods. The first one is the period between 2008-2011. The second one is the period when financial crisis began and includes the 2008-2009 period. And the last period includes 2011 which represents the time when the gold prices achieved the biggest historical values. The results show statisticaly unsignificant values of correlation coefficients for all 3 periods of estimation. Also paper found the unidirectional causality from stock market index S&P 500 to gold for the first and the second estimation periods.

Keywords: *crisis; correlation; stock market index; gold; causality.*

JEL classification: C12; G01.

Ельдін Добарджіч, Біляна Ракіч

ВЗАЄМОЗАЛЕЖНІСТЬ МІЖ ФОНДОВИМ ІНДЕКСОМ S&P 500 ТА ЦІНАМИ НА ЗОЛОТО У КОНТЕКСТІ ФІНАНСОВОЇ КРИЗИ ЯК ОСНОВА ДЛЯ ПРИЙНЯТТЯ МАКРОЕКОНОМІЧНИХ РІШЕНЬ

У статті досліджується взаємозалежність між готівковим золотом та фондовим індексом S&P 500 під час фінансової кризи. Кризу поділено на 3 періоди: перший – загальна тривалість, з 2008 по 2011 рр.; другий – початок кризи, 2008-2009 рр.; третій та останній – 2011 рік, в якому ціни на золото сягли свого історичного максимуму. Результати аналізу показали статистично незначну кореляцію індикаторів для всіх трьох періодів дослідження. Також виявлено однобічну каузальну залежність, що йде від індексу S&P 500 до ціни на золото, але тільки для першого та другого періодів.

Ключові слова: *криза; кореляція; фондовий індекс; золото; причинність.*

Форм. 5. Рис. 5. Табл. 5. Літ. 20.

Ельдин Добарджич, Биляна Ракич

ВЗАИМОЗАВИСИМОСТЬ МЕЖДУ ФОНДОВЫМ ИНДЕКСОМ S&P 500 И ЦЕНАМИ НА ЗОЛОТО В КОНТЕКСТЕ ФИНАНСОВОГО КРИЗИСА КАК ОСНОВА ДЛЯ ПРИНЯТИЯ МАКРОЭКОНОМИЧЕСКИХ РЕШЕНИЙ

В статье исследуется взаимозависимость между наличным золотом и фондовым индексом S&P 500 во время финансового кризиса. Кризис разделен на 3 периода: первый – общая длительность, с 2008 по 2011 гг.; второй – начало кризиса, 2008-2009 гг.; третий и последний – 2011 год, в котором цены на золото достигли своего исторического максимума. Результаты анализа показали статистически незначимую корреляцию исследуемых индикаторов для всех трех периодов исследования. Также обнаружена односторонняя каузальная зависимость, идущая от индекса S&P 500 к цене на золото, но только для первого и второго периодов.

Ключевые слова: *кризис; корреляция; фондовый индекс; золото; причинность.*

[1] Corresponding author, Associate in Scientific-Research Centre, State University of Novi Pazar, Serbia.
[2] Associate Professor, School of Economics, University of Nis, Serbia.

1. Introduction. Gold is the world's oldest international currency and has played a significant role in the most countries' currency systems in 1970s for instance. Most countries switch to the gold standard, a monetary standard under which the basic unit of currency is defined by a stated quantity of gold, linking the currencies to gold. Since the adoption of the gold standard the primary role of gold in the monetary system has changed and a global market of gold as an asset has developed. The process of rebalancing reserve portfolios has led central banks to be major holders of gold for more than 100 years. Although the adoption of gold standard followed by the reduction in the amount of the gold held by some central banks in the past few gears, they currently account for about 20% of above-ground stocks. As investment gold has been viewed as a hedge against inflation (Chua and Woodward, 1982) and exchange rate devaluation (Capie et al., 2005) and an extended literature has been developed on these relationships. Also, there is evidence that during time of political and economical crises and during market crashes as equity prices fall the price of gold rises. According to Smith, in times of economic uncertainty attention turns to investing in gold as a safe haven (Smith, 2002). There are evidences that gold tends to move in the opposites direction than shares and bonds and thus the importance of gold has increased under the globalization and the increasing correlations among different assets prices. Finally the links between macroeconomic fundamentals such as GDP, CPI, PPI, unemployment and gold have also been identified in many investigations (Christie-David et. al., 2000). Moreover, as gold has numerous applications in industry (health, chemical, technologies) the links between gold market and stock market indices have been also investigated indicating that changes in gold prices have greater impact in the resource and mining sector industries (H. Chan, R. Faff, 1998). The links between the stock market and the gold market are described above as there are evidences that these two markets are either related directly in the periods of economic instability or not, either indirectly as it seems that common macroeconomic fundamentals are related with the two markets.

Gold has been receiving a great deal of attention at financial markets recently. Furthermore, anecdotal evidence and financial presses also suggest that gold serves as a safe against the collapse of the value of other asset classes. However, investigation on diversification benefit of gold for stock portfolios and other asset classes is very limited. Recent studies that have examined stock-gold relationship are Chau (1990) and Hillier et al. (2006). Chau (1990) investigated the diversification benefit of gold bullion and gold stocks by simply focusing on the betas of these two asset classes against the stock market return. They find that the beta of gold bullion is virtually indistinguishable from zero, whereas gold stocks do not seem to be a meaningful diversification tool for stock portfolios. Hillier et al. (2006) employed a similar approach to Chau (1990) but expand their analysis to cover other precious metals, platinum and silver. They furthermore examine diversification properties of precious metals during very volatile market periods. Their results revealed hedging ability of precious metals, particularly during periods of abnormal stock market volatility.

The less than perfect or negative stock-gold correlation may provide the diversification benefit beyond the diversification benefit from stock-stock and stock-bond approaches. Moreover, the role of gold in the portfolio management context does not limit to a hedging instrument for other asset classes, but gold is also widely regarded

as an investment asset. In particular, the sharp rise in gold prices in recent years confirms this argument. Furthermore, in the context of hedging, the hedging ability of gold for stock portfolios is distinguishable from that of low risk asset classes such as bonds. It does not count on a property of being safe asset, but it generally relies on the negative correlation between stocks and gold.

A significant amount of literature now exists that examines the relationship between stock market performance and a range of macroeconomic and financial variables over a number of different stock markets and time periods. Smith provided a research and found that the short-run correlation between gold price and stock indices is frequently small and negative at European markets and in Japan, also gold and stock prices are not cointegrated. That is, there is no long-run equilibrium (Smith, 2002). Another paper provides empirical evidence on the relationship between the price of gold and stock price indices for the United States. 4 gold prices and 6 stock price indices are used. The short-run correlation between returns on gold and returns on the US stock price indices is small and negative and for some series Granger causality tests find evidence of unidirectional causality from the US stock returns to returns on the gold price set in the London morning fixing and the closing price. For the price set in the afternoon fixing there is a clear evidence of feedback between the markets for gold and the US stocks (Smith, 2001). Wang et al. explored the impacts of fluctuations in crude oil price, gold price, and exchange rates of the US dollar vs. various currencies on the stock price indices of the United States, Germany, Japan, Taiwan, and China respectively, as well as the long and short-term correlations among these variables. The empirical results show there exist cointegrations among fluctuations in oil price, gold price and exchange rates of the dollar vs. various currencies, and the stock markets in Germany, Japan, Taiwan and China. This indicates that there exist long-term stable relationships among these variables. Whereas there is no co-integration relationship among these variables and the U.S. stock market indices which indicates there is no long-term stable relationship among oil price, gold price and exchange rate and the US stock market index (Wang et al., 2010). The financial contagion literature examines the responses of investors to financial market shocks (e.g., Forbes and Rigobon, 2002). Investors seek diversification in their portfolios to reduce the risk of suffering heavy losses. International diversification is made possible by the less than perfect integration of international stock markets (Bai and Green, 2010; Chandar et al., 2009; Francis et al., 2008). However, in times of financial crisis, contagion effects may cause markets to comove strongly, even where macroeconomic fundamentals would not suggest strong interdependence (Dornbusch et al., 2000; Hasman and Samartin, 2008).

This paper investigate is there any interdependence between theses variables through correlation and causality testing during the financial crisis. The results could explain aspirations of investors in the crisis period and implications on macroeconomic policy decisions.

The rest of the paper proceeds as follows. Section 2 describes the data used in this paper. Section 3 report the methodology which is used in this paper. Section 4 presents the results and discussion. Finally, section 5 concludes the findings of this paper.

2. Data analysis. The data used in this study consist of daily observations of spot gold prices and a stock market index. All the data are obtained from DataStream International. The spot gold data is daily London gold bullion price quoted in US

dollars per troy ounce. The S&P 500 index is used as a proxy for the portfolio of the US stocks. The daily gold prices and the S&P 500 index cover 3 periods. First one is the period which includes observations from 01. January 2008 to 01. August 2011 (Graph 1). Second period is the crisis period which includes observations from 01. January 2008 to 01. August 2009 (Graph 2). And the third is the postcrisis period which includes observations from 01. January 2001 to 01. August 2011 (Graph 3).

The daily continuously compounded returns on gold and stock index S&P 500 are calculated as the natural logarithm of the ratios of the price relatives.

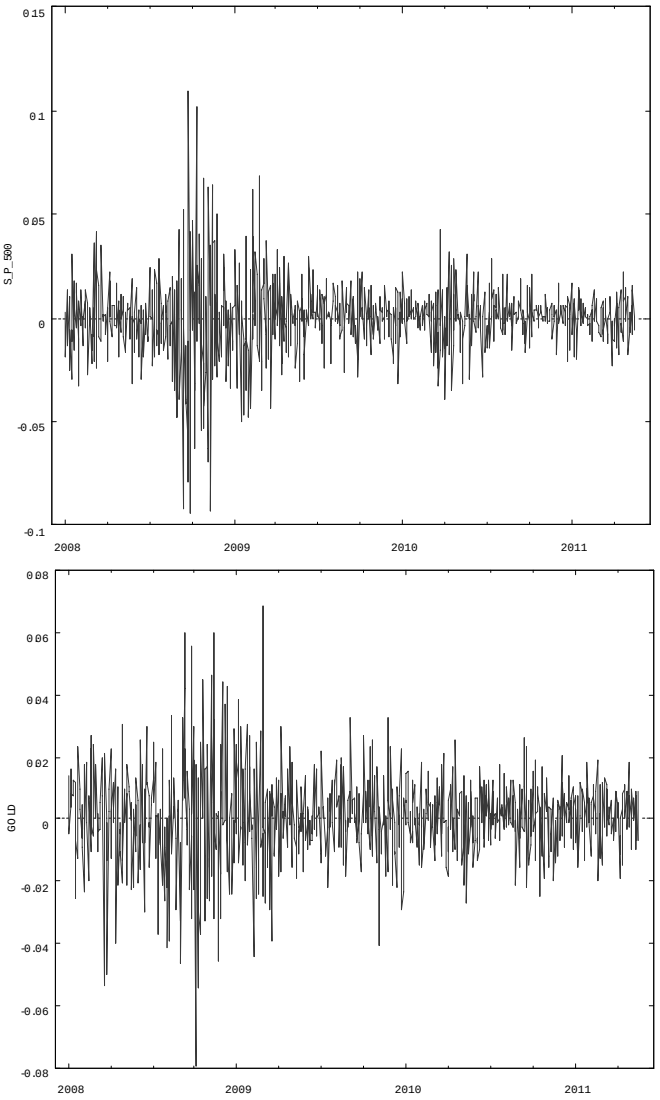

Figure 1. **Stock index S&P 500 and gold returns during from 01.01.2008-01.08.2011**

Source: Authors' calculations

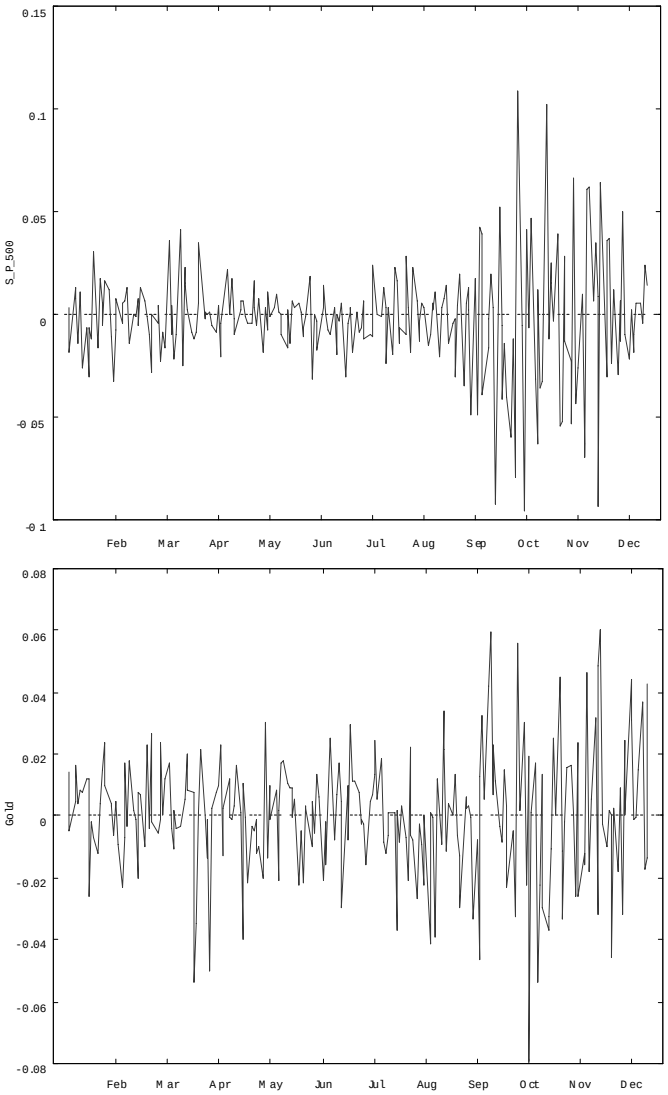

Figure 2. **Stock index S&P 500 and gold returns during from 01.01.2008-01.01.2009**

Source: Authors' calculations

Descriptive statistics for the stock index and gold returns are given in Table 1. These include the distribution of the mean, the standard deviation, coefficient of variation, the skewness and the kurtosis. The first period which includes 879 observations has negative value of mean for S&P 500 and positive for gold returns. The values for standard deviations are very close to each other for S&P and gold returns which means the risk for investing in them near to be similar. By the way, coefficient of variation which is the measure of volatility level, is much more bigger for S&P 500 than for gold returns.

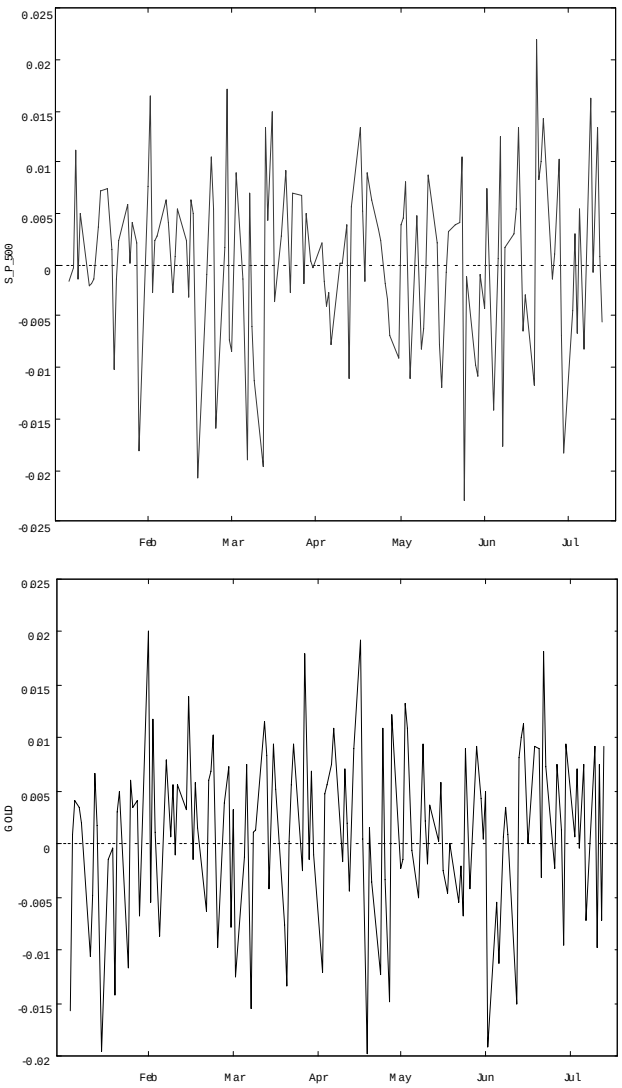

Figure 3. **Stock index S&P 500 and gold returns during from 01.01.2011-01.08.2011**

Source: Authors' calculations

The second period, which is the period when world financial crisis began, shows a few time smaller value for the coefficient of variations of S&P 500, but bigger value for the gold returns. The negativity of the skewness is seen as a sign of nonlinearity in the dynamics of stock and gold markets. All of the displayed skewness statistics has asymmetric distributions for all 3 periods and all are skewed to the left (negative skewness).

Kurtosis provides a measure of the "thickness" of the tails in the distribution relative to normal distribution. For normal distribution, kurtosis is usually equal to 3.

For the first period S&P 500 and gold returns have excess kurtosis which means that they have a thicker tail and a higher peak than a normal distribution. The second period shows that S&P 500 returns also have thicker tail than a normal distribution but gold returns show thinner tail compared with normal distribution.

Table 1. **Descriptive statistics for logarithmic stock index S&P 500 and gold returns**

	Num. of obs.	Mean	Minimum	Maximum	Stv.De	C.V.	Skewness	Kurtosis
First period (2008-2011)								
S&P 500	879	-6.1e-5	-0.094	0.1095	0.0179	291.59	-0.133	6.7816
Gold	879	0.0007	-0.079	0.0684	0.0143	19.181	-0.139	3.4547
Second period (2008-2009)								
S&P 500	246	-0.0004	-0.094	0.1095	0.0220	48.129	-0.066	4.3794
Gold	246	0.0005	-0.079	0.0684	0.0171	33.701	-0.086	2.3018
Third period (2011)								
S&P 500	140	0.0004	-0.023	0.0220	0.0083	19.56	-0.389	0.2876
Gold	140	0.0011	-0.019	0.0201	0.00818	7.1871	-0.374	-0.086

Source: Authors' calculations

The last period for both returns show smaller values of kurtosis than normal distribution have. That means that both returns have thinner tails and smaller peaks than a normal distribution.

Table 2 gives a comparative illustration of the total annual returns in 2006-2010 for investment in stock market index S&P 500 and gold. As we can see, especially noticeable is 2008 when investment in the index brought negative return of 38%. On the other side, investment in gold brought small but positive return of 4.32%.

Table 2. **Total annual returns for S&P 500 and Gold**

S&P 500			Gold		
Year	Annual Return	1$ Investment Gives	Year	Annual Return	100$ Investment Gives
2006	15.79%	$8.85	2006	23.20%	167.13$
2007	5.49%	$9.33	2007	31.92	220.48$
2008	**-37.00%**	$5.88	2008	**4.32%**	230.00$
2009	26.46%	$7.26	2009	25.04%	287.40$
2010	15.06%	$8.35	2010	-	-

Source: "MarketWatch: $SPX", Kitco.com

Figure 4 shows the period of the current global financial crisis. The crisis intensified in September 2008 with the collapse of Lehman Brothers. Fears of a global recession sent stock markets plummeting in October 2008. Since October 2008 the gold price index has surged, indicating a positive response to the intensification of the financial crisis. This is in sharp contrast to the declining value of commodity index returns over the same period (Bauc and McDermott, 2010).

The dramatic rises in gold prices that have been witnessed in the past 18 months can therefore be explained by increased investor interest in the precious commodity. According to "The Economist" the recent surge in gold prices (since the start of 2009) has been driven by investors looking to preserve their wealth. This reinforces the perception of gold as representing a secure investment for those with something to lose.

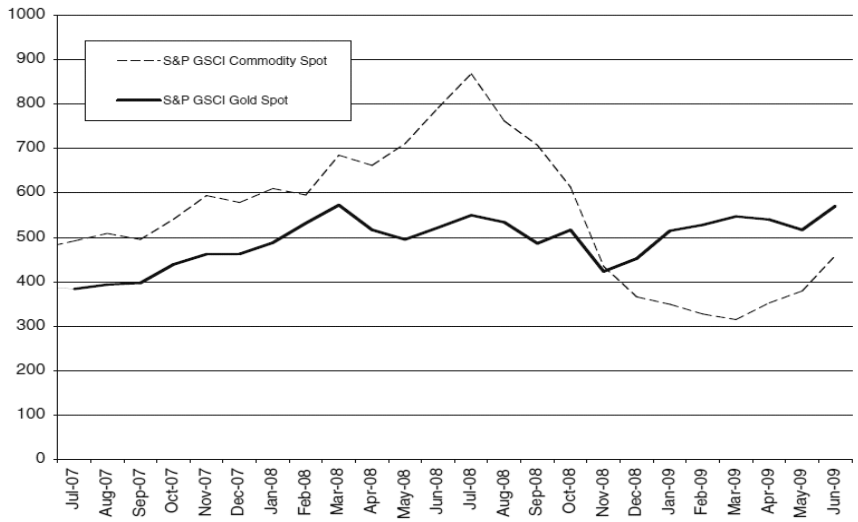

Figure 4. **The evolution of S&P GSCI commodity and gold spot indices in the global financial crisis in 2007-2009**

Source: Baur McDermott, 2011

3. Methodology. Originated by Karl Pearson about 1900, the coefficient of correlation describes the strength of the relationship between two sets of interval-scaled or ratio-scaled variables. It can assume any value from -1.00 to +1.00 inclusive. A correlation coefficient of -1.00 or +1.00 indicates perfect correlation. If there is absolutely no relationship between the two sets of variables, Pearson's r is zero. A coefficient of correlation r close to 0 shows the relationship is quite weak. The same conclusion is drawn if r is close to 0 with a negative sign. Coeficients r which are close to 1 with plus and minus sign have equal strength, both indicate very strong correlation between two variables. That means the strength of the correlation does not depend on the direction or sign. So, coefficient of correlation r represent a measure of the strength of the linear relationship between two variables.

In this process first of all we must find the coefficient of correlation of every indices pair. Conceptual form of coefficient of correlation leads to the following formula:

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X^2)][n(\sum Y^2) - (\sum Y)^2]}} \quad (1)$$

After we find coefficient of correlation r we need to do t-test for the significance of correlation coeficient. This t-test will show if there is a correlation between two indices is significant or not. The formula for t-test is:

$$t = r\frac{\sqrt{(n-2)}}{1-\sqrt{r}} \quad (2)$$

This test includes testing two hypotheses, the null and the alternate one. The first one means the correlation in the testing population is zero. And the second one means the correlation is different from zero.

H_0:The correlation in the population is 0

H_1:The correlation in the population is different from 0

Granger (1969) proposed a time series data-based approach to determine causality. In the Granger sense, *x* is a cause of *y* if it is useful in forecasting *y*. In this framework, "useful" means *x* is able to increase the accuracy of the prediction of *y* with respect to a forecast, considering only past values of *y*.

This paper access Granger causality in a direct way, by regressing each variable on lagged values of itself and the other, such as in the following:

$$Y_t = \beta_0 + \sum_{j=1}^{J} \beta_j Y_{t-j} + \sum_{k=1}^{K} \gamma_k X_{t-k} + \mu_t \quad (3)$$

We can simply use an F-test or the like to examine the null hypothesis. The choice of J and K lags is critical; insufficient lags yield autocorrelated errors (and incorrect test statistics), whereas too many lags reduce the power of the test. This approach also allows for a determination of causal direction of the relationships, as we can also estimate the reverse model:

$$X_t = \beta_0 + \sum_{j=1}^{J} \beta_j X_{t-j} + \sum_{k=1}^{K} \gamma_k Y_{t-k} + \mu_t \quad (4)$$

4. Results and discussion

Table 3. The values of the Pearson correlation coefficient *r* and the values of t-test for its significance

Indices pair	Coefficient of correlation r	t test[3] of significance correlation coefficient	the margin value for t test[4]
1. S&P 500 and Gold (Period 2008-2011)	0.04510	1.69376	from-1.960 to +1.960
2. S&P 500 and Gold (Period 2008-2009)	0.03003	0.80422	from-1.960 to +1.960
3. S&P 500 and Gold (Period 2011-)	0.04187	0.61893	from-1.960 to +1.960

Source: Authors' calculations

Correlation results for all 3 periods (Table 3) show neglible positive values but with no significance between variables. This means there is no significance between the S&P 500 and gold returns correlations which would affect the mutual dependence when it comes to certain changes in the trends of their values. The results are interesting from the aspects of the estimation period (2008-2011) when the financial crisis happened. We can conclude that hypothesis H0 is accepted. The value of the t-test is the biggest for the first period and it was expected because the first period includes the most number of observations. The second period, when financial crisis began and when the stock market index S&P 500 experienced a sudden and the biggest drop (November 2008), shows smaller value compared with the first but bigger than in the third period. The third period is the period when gold reached its' highest value pre-

[3] with 0.05 significance level.

[4] This value depends of the number of observations or df in Student's t distribution table, which are in our cases for all indices paires more than 450, so in Student's t distribution that appropriate to infinity for df values.

viously. Financial crisis shows that gold prices do not have direct influence on the economic activity of the world major economies. Gold prices only represent investor decisions in times of uncertainty and times when investing in shares does not bring the desired profit.

During the period of global financial crisis, stock markets experienced a large drop but gold price continues to increase (Figure 5).

The procedure for testing statistical causality between stock market index S&P 500 and gold returns 15 is the direct Granger causality test proposed. The results of the causality test are presented in Table 5.

Granger causality tests are conducted for variables to establish whether the movement in stock market prices from S&P 500 has an impact on movements in prices of gold and vice versa and apply Akaike's information criteria to ensure the lag length specified in the causality tests is optimal. Table 4 shows the number of time lags used in causality estimations.

Table 4. **Optimal endogenous number of lags from information criteria**

	OPTIMAL NUMBER OF LAGS Akaike Info Criterion (AIC)
First period (2008-2011)	
S&P 500 and Gold	3
Second period (2008-2009)	
S&P 500 and Gold	2
Third period (2011-)	
S&P 500 and Gold	2

Notes: searched up to 10 lags of 1. difference
Source: Authors' calculations.

The statistics are defined as follows:

$$F = \frac{[(RSS_r - RSS_{ur})/k]}{RSS_{ur}/[n-2k-1]} \quad (5)$$

where SSR_r and SSR_{ur} are two sums of squared residuals related to the restricted and unrestricted forms of the equation; the elements that form the degrees of freedom are n, that is, the number of observations, whereas k represents the number of lags. The same procedure is used to test for the inverse Granger causality relation in 2. Table 5 shows all the types of causality relationships.

Table 5. **Results of Granger Causality Tests**

Null Hypothesis	Obs.	F-statistics	Probability	Decision
First period (2008-2011)				
S&P 500 does not Granger cause Gold	879	4.57150*	0.0106	Reject
Gold does not Granger cause S&P 500	879	0.70684	0.4935	Accept
Second period (2008-2009)				
S&P 500 does not Granger cause Gold	246	2.9770*	0.0305	Reject
Gold does not Granger cause S&P 500	246	1.9835	0.1145	Accept
Third period (03.01.2011-01.08.2011)				
S&P 500 does not Granger cause Gold	140	0.0997	0.9052	Accept
Gold does not Granger cause S&P 500	140	0.5141	0.5986	Accept

*Significance at the 5% level
Source: Authors' calculations

Table 6 shows the results of the Granger causality tests. We find evidence of unidirectional causality from S&P 500 to gold returns for the first and the second estimation period. That means the stock market index have impact on gold returns in all period of financial crisis. We can also say that the past values of S&P 500 predict present or future values of gold. That also means that S&P 500 is the first move and gold follows it, but with a certain delay. The third period shows evidence of no causality between these variables, so S&P 500 do not have impact on any movement in gold prices. It is interesting because in this period gold reached its highest historical value.

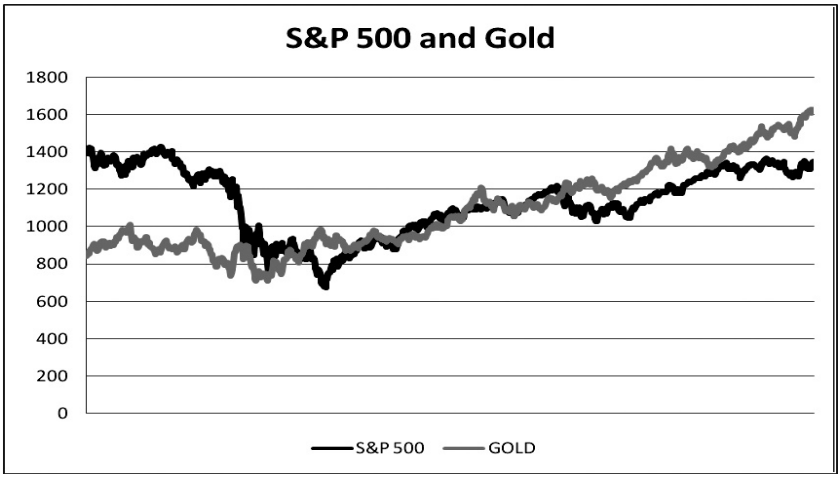

Figure 5. **Moving of the spot prices of S&P 500 and Gold in the period 2008-2011**

Source: Authors' calculations

5. Conclusion. This paper investigates the interactions between stock market index S&P 500 and gold returns for 3 periods of the examination. The study uses daily data on the defined time series. The required data have been collected from the database of Data Stream International. The results show very small values for coefficient of correlation for all 3 periods. Also, which is more important, t-test shows unsignificant results for all the coefficients of correlation. That means that stock market index S&P 500 and gold returns are not correlated. So, every positive or negative movement of the S&P 500 daily returns does not have influence on movements of gold returns. Next, the paper explores causality between them using a direct Granger causality method. We find evidence of unidirectional causality from S&P 500 to gold for the first and the second period of observations. So, stock market index S&P 500, as a represent of the biggest world economy shows that in the period of financial crisis have strong impact on gold prices.

The answer about the decision where is better to invest is given in Table 1 which shows more positive values for gold returns and also smaller values o standard deviations and coefficient of variations. It seems less risky to invest in gold than in stock market index S&P 500 and returns are less volatile than returns of S&P 500. Decision

about where to invest also depends on investor risk preferences. The results are interesting because they include influence of the world financial crisis on the stock market index S&P 500 and gold prices. Lack of statistically significant correlation coefficients for all 3 periods leads us to the conclusion that these two economic indicators are independent from each other. The results also give explanation that in the period of the financial crisis investors are more focused on investing in safer assets, which is gold because its quantity is limited and has intrinsic[5] value. One of the primary reasons for the increasing price of gold, stems not only from its physical rarity throughout the world, but from its perceived value as an investment opportunity in the face of a declining dollar. While currencies are tied to political actions, gold remains stable compared to national currencies. Gold is also a tangible investment – you can hold it in your hands and feel the weight. This is not to say that being able to touch your investment is a psychological boost. In fact, a tangible investment gives you more selling power than other investments like stocks or bonds. Impact of this paper could become a contribution to macroeconomic policy decisions. In the period of crisis many governments and central banks decide to buy gold to protect against possible new breakdowns in very uncertain financial sector. Especially this is characteristic for emerging countries which have to keep an eye on the stability of their monetary systems in times of crisis under pressure due to lack of investment, and thus the reduction of foreign exchange reserves with the aim of maintaining macroeconomic stability.

Looking at specific crisis periods, Baur and McDermott (2010) found that gold was a strong safe for most developed markets during the peak of the recent financial crisis. Gold was also a strong safe for markets in the US and Canada during the 1987 stock market crash.

These findings suggest that investors didn't give up on the US financial markets such as S&P 500, as there were recorded rises in its index and in its volume, mainly in 2009-2010 – the years when gold prices soar. These rises in the S&P500 happened despite the economic slowdown in the US, and the steps the Federal Reserve taken which might have weaken (time will tell) the USD during those years. Thus there isn't necessarily a tradeoff between investing in gold and investing in stock market. It could be that investors of gold diverted their funds from other sources of investment. This last sentiment is worth exploring in the future.

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