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The Relationship Between Volatilities on the Gold Market and US Stock Market in the Presence of Geopolitical Risks

تأثير المخاطر الجيوسياسية على سوق الذهب و سوق الأوراق المالية الأمريكية

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مؤشر المخاطر الجيوسياسية، سعر الذهب، سوق الأوراق المالية، نموذج bekk – garch

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ABSTRACT

The stock market as well as the gold market are the most important markets in all developed countries. Due to the urgent need of policy makers, investors and speculators, especially when tensions between countries arise, studying these markets is important. The relationship between gold and the stock markets, in the presence of global tension and conflicts, is re-explored by introducing the uncertainty that induces shocks, such as the recent index, which was calculated by Caldara and Iacoviello in 2016, referred to as geopolitical risk index. The gold price, S&P500 index and geopolitical risk index are used, for period starting from 1960 to 2017 in order to construct a VAR-BEKK-GARCH model, which computes the mean returns, as well as the variance-covariance, especially if the time-varying stock–gold covariance, their returns and their variances are influenced by geopolitical risk. The present model showed a negative relationship between the volatilities on gold prices, as well a significant effect on the spillover between the stock market and the gold market. These findings are important for investors to manage their portfolio effectively.

الملخص

يعتبر سوق الاوراق المالية و كذلك سوق الذهب من اهم الاسواق تداولا في جميع البلدان خاصة المتقدمة لذلك من المهم دراسة هذه الاسواق و العلاقة التي تربطهما نظرا للحاجة الملحة و المستمرة لمسؤولين عن اتخاذ القرار و المضاربين في الأسواق لاسيما عند تصاعد التورات الجيوسياسية بين البلدان. سوف يتم اعادة استكشاف العلاقة بين سوق الذهب والأوراق المالية اثناء التوتر والصراع العالميين الذين يصاحبهما شيوع حالة من عدم اليقين الذي يسبب الصدمات، مثل المؤشر الأخير الذي تم حسابه من طرف **Caldara and Lamoriello** في عام **2016** يدعى مؤشر المخاطر الجيوسياسية. سوف يتم استخدام سعر الذهب ومؤشر **S & P500** ومؤشر المخاطر الجيوسياسية للفترة من **1960** إلى **2017** من خلال نموذج **VAR-BEKK-GARCH** من أجل القيام بنمذجة **mean returns** بالإضافة إلى **variance-covariance** ثم عرضه إذا كان المخزون المتغير بمرور الوقت التغاير البطيء ، تتأثر عائداتهم وفروقهم بالمخاطر الجيوسياسية. أظهرت نتائجنا وجود عوائد سلبية في الذهب ، وكذلك تأثير كبير على التباين بين سوق الأوراق المالية وسوق الذهب. هذه النتائج مهمة للمستثمرين لإدارة محافظهم المالية بفعالية.

1. Introduction

Historically, gold has always been considered a unique raw material thanks to its value-retention property, especially in troubled times. Since the subprime crisis of 2008, we have seen gold prices reach historic levels. Today, gold market experts agree that gold is a safe haven and that its demand for gold is motivated by minimizing the risk of extreme loss (or systemic risk). The safe-haven characteristic of gold is reflected in changes in its price in times of crisis, as evidenced by several studies (Koutsoyiannis, 1983; Cai et al., 2001; Juttila & Raatikainen, 2017). The main goal of this research is to deepen our understanding of this popularly held belief in the financial literature. Indeed, we cannot talk about gold as a financial asset without referring to its safe-haven nature. This characteristic implies that gold is greatly sought after a collapse in stock market returns. In other words, uncertainty, which is usually accompanied by high volatility and stock market disengagement, remains the most moderating factor of gold prices.

The history of the evolution of the stock market shows that episodes of volatility are often followed by calm periods. The intensity of these volatile periods is, however, likely to prompt investors to withdraw from the stock market in favor of other asset classes, such as gold. Similarly, the global situation has a direct impact on the price of this precious metal. When tensions and geopolitical crises arise, the price of gold tends to rise because of its popularity as a safe haven.

In this work, we study the link between the volatility of the stock market in the form of the S&P500 index and the volatility of the gold price, combined with geopolitical factors in the form of the Geopolitical Risk Index. A review of the literature in this area guides us in choosing models to assess the degree of this linkage and the influence that geopolitical factors exert. We endeavor to show and explain how the variation in volatility over time, as well as its transmission, affects wealth-allocation strategies and how the gains of international diversification could be challenged.

During uncertain political times or after an adverse economic event, greater attention is drawn to gold's safe-haven quality. This metal reassures people because it is tangible, and it enables hedging against fluctuations in stock market prices and other risks. The gold market, unlike other asset classes, is not exposed to the debts or solvency of counterparties (Smith, 2001).

Cai et al. (2001) use very-high-frequency data, covering the period between 1995 and 1997, in order to identify the events that exerted the most influence on gold yields. Among these were the Asian financial crisis of 1997 and the political tensions in South Africa in 1996. According to Smith (2002), an increase in uncertainty associated with political events or increased financial risk causes the stock market to fall in value and the gold price to increase. Draper et al. (2006) support the idea of a strong indirect relationship between the advent of political crises and fluctuations in the gold price in response to stock market volatility. It appears that gold has a greater negative correlation during periods of negative returns and strong volatility in stock markets. This finding is supported by Hillier et al. (2006), who argue the existence of crisis and stress influences on the gold market if we admit that periods of negative returns on the stock market, coupled with strong market volatility, is typical of economic and political crisis situations. Christie-David et al. (2000) take a different approach. They study the effect of many macroeconomic announcements on the price of futures for gold and interest rates. The data sample runs from 1992 to 1995 with a sampling frequency of 15 minutes. They show that the unexpected components of macroeconomic indicator news releases have a substantial effect on future interest rate contracts and a smaller effect on gold yields. These results are interesting because they support the hypothesis that gold reacts differently than other assets: the authors

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claim that "The return dynamic prevailing in the future metal markets should be cognizant of this".

Political events can be understood as exogenous incidents affect the decisions of the actors towards the functioning of markets and the economy as whole by affecting both supply and demand channels, may increase disinvestment and cause economic contraction. Some other research works such as that of Pástor and Veronesi (2013) and Dimic et al. (2016) confirm this result. Moreover, Gaibulloev and Sandler in 2008 show that the international political environment influences the agents' sentiment and behaviour, the economy and markets. Additionally, Kollias et al. (2013) as well as Omar et al. (2016) have demonstrated that instabilities of political climate may increase risks in equity markets, in addition to portfolio allocation and diversification. Furthermore, Choudhry (2010) and Drakos and Kallandranis (2015) argued that many events such as elections, political upheavals, terrorist attacks, simply geopolitical friction, armed conflicts and others distress economic performance increase the uncertainty in global markets.

The objective of this research is to understand the effect of geopolitical risks on the gold-stock covariance, their returns and their variances. While addressing the relationship between gold and stock prices, which was found to be roughly a reverse relationship (Hood and Malik, 2013), in different political events, the geopolitical risk index is introduced as an exogenous variable to illustrate its impact on gold-stock. This information is particularly pertinent for investors, wishing to considerably improve the performance of their portfolio.

Our analysis is based on two variables namely: the S&P500 stock index and the gold-price real returns, measured with a monthly frequency, during the period from 1985 until 2017. The geopolitical risk index (GPR) was downloaded from "www.policyuncertainty.com". This data set was constructed by Caldara and Iacoviello (2016), to examine its effect on gold-stock covariance, their returns and variances. To the best of our knowledge, this is the first time that the GPR index has been introduced as an explanatory variable in the mean and the variance equation of the MV-GARCH model. This model is motivated by its capability to model the spillover between stock market and gold, on the one hand, and on the other hand, it allows us to examine the effect of the GPR on the volatility returns in the stock and gold markets.

Our findings show that a higher geopolitical risk is associated with lower volatility. Moreover, there is a negative relationship between geopolitical risk and gold returns, and to a smaller degree with the covariance between the two markets. Our result confirms the existence of influences of tension and stress on the gold market, if the period of negative return, coupled with strong market volatility, is typical of a situation of geopolitics agitation, described by a growth in GPR index. The rest of the paper is organized as follows. The second section presents the previous studies. The third section describes the data and methodology used in this paper. The results are shown and discussed in the fourth section.

2. Previous Studies

Among the early investigations, Von et al. (1989) studied the determinants of stock index, such as the FTSE 100, S&P500, DAX and Nikkei 225 by introducing gold price as a factor. Their results show that gold price can affect stock price movements. More recently, Tully and Lucey (2007) have studied the effects of macroeconomic variables on gold yield using the APGARCH model, during the period that covers the two stock market crash of 1987 and 2001 and from 1983 until in 2003. Their results prove the insignificance and negative relationship between these two economic variables.

Do and Sriboonchitta (2009) focused on examining possible relationships between international gold prices and six ASEAN emerging markets during the period between July 28, 2000 and March 31, 2009. Both authors applied Johansan's cointegration approach to explore the long-term relationship between gold prices and certain ASEAN stock markets. Their results show the absence of a cointegration relationship between the six stock market indexes and the gold market and recommend the diversification of the portfolios.

Gilmore et al. (2009) used the error correction model to highlight the long-run relationship between the stock market and the gold market. An unidirectional cause-and-effect relationship has been found between these two markets.

Among the works, which have studied the dynamic interactions between gold price changes and stock market are that of Baur and Lucey (2010). They have shown that during the period of stress and stock market turmoil, such as the US, UK and German markets, gold has played as a safe haven. The same finding applies also to Australia, Canada, Japan and major emerging markets such as the BRIC countries (Brazil, Russia, India and China).

Baig at al. (2013) examined the relationship between gold prices, oil prices and KSE100 return. Their work helps investor to diversify their portfolio. They use the monthly variables data for the period covering 2000 to 2010. By applying cointegration test, they concluded that Gold prices growth, Oil prices growth and KSE100 return have no significant relationship in the long run.

Arouri et al. (2015) analyze the relation between gold prices and China stock market during the period covering from 2004 to 2011 using the famous VAR-GARCH model of Ling and McAleer (2003) and other diversification model (CCC, DCC, BEKK, Scalar BEKK, and full-BEKK GARCH model) for robustness purpose. They find a significant return and volatility cross effects gold prices and stock prices and prove the power of VAR-GARCH model. The objective of their paper is to focus on the fact that how the role of gold assets acts as safe haven for stocks holders in the Chinese stock markets.

Taufiq et al. (2015) examined the dynamics of co-movements between gold returns and FTSE 100, S&P 500 and Nikkei 225 volatility and returns during the recent global financial crisis. They used the multivariate nonlinear model and introduced changes in the three-month LIBOR rates. The authors proved the existence of a significant nonlinear feedback effect among time series for all markets during the periods of financial crisis, which is not present in pre-crisis period. Moreover, their results proved that gold may not perform well as a safe haven during the financial crisis but, may be used to hedge against stock market returns and volatility in periods of stability.

Nguyen et al. (2016) studied the relationship between stock markets and gold prices by applying various copula methods to verify if gold act as a safe haven. They studied a daily data over the period from 1999 to 2010, which covered seven countries. The findings of this research show that gold may be a safe haven asset during market crash for five countries including UK, US, Malaysia, Singapore and Thailand markets. These findings can help an investor to comprehend portfolio diversification benefits during conflict and tension periods.

It is worthwhile to mention that most of the literature dealing with the relationship between gold price and stock markets has focused on expanding MV-GARCH models, causality tests, VEC, DCC and Single copulas.

3. Materials and Methods

Form a theoretical point of view, two predominant strands can be identified from the literature about the relationship between gold prices and stock markets. On one hand, this relationship between two markets was found to be either negative or positive. In terms of empirical evidence on the other hand, and as shown in the previous section, the relationship between gold and stock prices is not stable and do not seem to be support by any robust and unequivocal empirical evidence (Baur and Lucey, 2010; Naifar, 2012; Meng and Liang, 2013 and Mensi et al., 2013). Moreover, following the results of Do and Sriboonchitta (2009) the volatility spillover effect among gold prices and stock returns appears to be bidirectional in many frontier markets but for developed stock markets the transmission is frequently unidirectional (from gold to stock markets).

In this study, previous models, describing the relationship between gold prices and stock markets. In fact, this index is introduced as an exogenous factor, which is unrelated to the market. It induces several other factors such as tensions, friction and confrontations between global economic actors. The latter factors and others, such as conflict, war and terrorist acts can cause disruptions in international financial flows and thereby affect stock markets. Furthermore, a political tension, such as the Arab spring, does not only cause the destruction of human and physical capital, but has a spillover effect and may have economic repercussions. The geopolitical instability, conflict and insurgencies can shake the gold and equity markets, as discussed by Omar et al. (2016) in their works.

GPR is a monthly index that quantifies the risk linked and generated by events such as pressures and frictions between states, confrontations, armed conflicts and terrorist acts. The normal course of international relations can be profoundly affected by such events. As exposed earlier, the instability, uncertainty and risk generated in such cases is transmitted to influence the performance and sentiment of the market actors (*inter alia:* Choudhry, 2010; Kollias et al., 2013 and Drakos and Kallandranis, 2015).

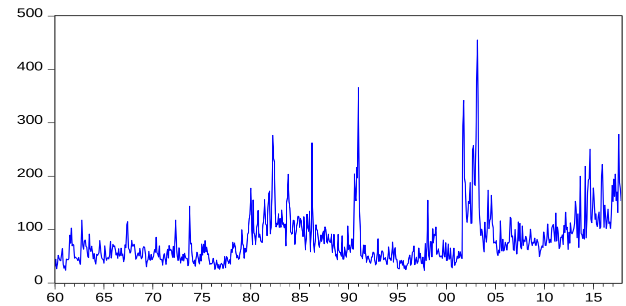
The GPR index is calculated by Caldara and Iacoviello in their paper, which was cited earlier, in an effort to model the occurrence of words associated with geopolitical tensions in the major international newspapers. Figure 1 shows the evolution of the GPR index throughout the period from 1960 to 2017, the most extreme points correspond to the Gulf War in 1990, the attacks of 11 September 2001, the attacks of Madrid and London back in March 2004 and July 2005. Other events have affected the stock markets, we mention, in chronological order, the Falklands War in 1983, the Russo-Japanese war in 1904, the Balkan war in 1990 and the longest war of modern times namely, the Iraqi war.

It is worth mentioning here that the GPR index calculated by Caldara and Iacoviello has been recently used by Das et al. (2019) as a measure of geopolitical risk. The authors concluded that "this index is more specialized because it captures specific events and should have an explicit impact on financial variables". Unlike econometric models, which use binary dummy variables to model the geopolitical risk effect, the GPR index is continuous rather than binary. Moreover, the frequency of this index is monthly, hence the possibility of including it in a model of time series.

It turns out that geopolitical risks tend to affect economic conditions and financial markets. Indeed, central bankers, professional investors and the financial press consider this risk as one of the determinants of investment decisions (Caldara and Iacoviello, 2016).

The attacks of September 11, 2001 had a significant economic impact on the United States and the New York Stock Exchange (NYSE). Indeed, the Dow Jones fell 1,369.70 points (14.26%) to close at 8,235.81 points and the S&P 500 27,54 points (11.6%) to close at 965.03 points. This was the worst week recorded by the Dow Jones since the Great Depression.

Figure. 1. The GPR index 1960–2017.



Source: www.policyuncertainty.com

Our analysis is based on two variables: the S&P500 stock index1 and gold-price real returns, measured with a monthly frequency from 1985 until 2017. The data is obtained from the World Bank Commodity Price Data (The Pink Sheet) for gold ($/troy oz) (RG) and for the S&P500 stock index from the Global Financial Database (RS&P500). Taking into account, that nominal values of both S&P500 stock index and gold-price are deflated by the CPI to find their real counterparts. The geopolitical risk index (GPR) is obtained from www.policyuncertainty.com, and its effect on the gold-stock covariance, their returns and their variances. The GPR index is considered as an exogenous variable in a VAR-BEKK-GARCH model. Engle and Kroner in 1995 proposed the BEKK-GARCH(1,1) model to take advantage of parsimony. So, to determine how the variances-covariances move over time, the multivariate GARCH is used and particularly, the multivariate GARCH formulation proposed in 1995 by Baba, Engle, Kraft and Kroner. Interestingly, the bivariate VAR-BEKK-GARCH(1,1) model was used to model Pearl Harbor attack, with the introduction of the geopolitical risk index in the building of the mean, variances and covariance matrices. More specifically, Eq. (1) represents the form for the conditional mean,

$$X_t = \gamma + \delta \sum_{i=1}^{r} X_{t-i} + \lambda GPR_t + \varepsilon_t \tag{1}$$

where vector $X = (RG, RSP500)$ represents the returns in real terms of the gold price (RG) and stock (RSP500) markets, respectively. The lag length, denoted by "p" in the above equation, is computed by the application of Akaike information criterion (AIC). In equation (1), the geopolitical risk index at time t is denoted by GPR_t in the mean and variance-covariance equation. The residual vector $\varepsilon = (\varepsilon_1, \varepsilon_2)$ is a bivariate random variable with $\varepsilon_t \mid \Phi_{t-1} \sim GED(0, \mathrm{H}_t)$, where

$$\mathrm{H}_t = \begin{bmatrix} h_{11t} h_{12t} \\ h_{21t} h_{22t} \end{bmatrix}$$

is the corresponding conditional variance covariance matrix, which can be expressed as:

$$\mathrm{H}_t = \mathrm{C}_0\mathrm{C}_0' + \mathrm{A}'\varepsilon_{t-1}\varepsilon_{t-1}'\mathrm{A} + \mathrm{B}'\mathrm{H}_{t-1}\mathrm{B} + \mathrm{K} \bullet GPR_t, \tag{2}$$

Equation (2) can be equivalently written as follows:

1 The S&P 500 is a stock market index that measures the stock performance of 500 large companies listed on stock exchanges in the United States. It is one of the most commonly followed equity indices, and many consider it to be one of the best representations of the U.S. stock market.

$$H_t = \begin{pmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{pmatrix}\begin{pmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{pmatrix}' + \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix}' \varepsilon_{t-1}\varepsilon'_{t-1} \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix}' H_{t-1} \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} + K \bullet GPR_t \quad (3)$$

where K, is the coefficient matrix for the GPR and the operator "•" is the element by element Hadamard product.

It follows from the above equations that the BEKK-GARCH model can be expressed as follows:

$$h_{11,t} = c_{11}^2 + \alpha_{11}^2\varepsilon_{1,t-1}^2 + 2\alpha_{11}\alpha_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha_{21}^2\varepsilon_{2,t-1}^2 + \beta_{11}^2 h_{11,t-1} + 2\beta_{11}\beta_{12}h_{12,t-1} + \beta_{21}^2 h_{22,t-1} + k_{11}GPR_t \quad (4)$$

$$\begin{aligned} h_{12,t} = {} & c_{11}c_{21} + \alpha_{11}\alpha_{12}\varepsilon_{1,t-1}^2 + (\alpha_{21}\alpha_{12} + \alpha_{11}\alpha_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha_{21}\alpha_{22}\varepsilon_{2,t-1}^2 + \beta_{11}\beta_{12}h_{11,t-1} + \\ & (\beta_{21}\beta_{12} + \beta_{11}\beta_{22})h_{12,t-1} + \beta_{21}\beta_{22}h_{22,t-1} + k_{12}GPR_t \end{aligned} \quad (5)$$

$$h_{11,t} = c_{11}^2 + c_{22}^2 + \alpha_{12}^2\varepsilon_{1,t-1}^2 + 2\alpha_{12}\alpha_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha_{22}^2\varepsilon_{2,t-1}^2 + \beta_{12}^2 h_{11,t-1} + 2\beta_{12}\beta_{22}h_{12,t-1} + \beta_{22}^2 h_{22,t-1} + k_{22}GPR_t \quad (6)$$

The parameters namely, the mean and the variance in the above equations, can be jointly estimated by maximum likelihood method.

In order to enhance the robustness of the proposed model and to determine the effect of the time lag on the geopolitical risk index GPRt-1 at time t-1, gold prices and stocks markets, Eqs. (1) and (2) are rewritten as follows:

$$X_t = \gamma + \delta\sum_{i=1}^{r} X_{t-1} + \lambda_2 GPR_{t-1} + \varepsilon_t \quad (7)$$

$$H_t = C_0C_0' + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B + \Theta \bullet GPR_{t-1}, \quad (8)$$

4. Results and Discussion

In our model the variables representing gold price returns, S&P500 and GPR index are I(1) processes. Table 1 summarizes the descriptive statistics. We see from Table 1 that stock mean returns are positive and higher than gold market returns, but not statistically significant in both cases. However, this is not the case for GPR index. In terms of volatility, we can detect the presence of Heteroscedasticity in all cases.

Table 1.: Descriptive statistics.

	observations	Sample mean	t-Statistc (Mean=0, p-value)	Sample Variance	Skewness	Kurtosis (excess)	Jarque-Bera	Ljung-box test Q(16) p-value	ARCH(16) LM Test p-value
Gold price_Returns	696	0.0055	0.732795	0.201120	3.079276	58.77698	91320.9	85.513	5.539189
			(0.4639)			<001***	<001***	<001***	<001***
SP500_Returns	696	0.0136	0.397815	0.902423	0.080307	12.73561	2749.430	145.49	3.574348
			(0.6909)		<001***	<001***	<001***	<001***	<001***
GPR_Index	696	81.727	39.123	50.34977	2.497819	12.70609	3455.771	107.18	3.4236
			<001***		<001***	<001***	<001***	<001***	<001***

It is important to mention that table 1 indicates that the skewness coefficient of S&P500 returns is smaller than that of gold price returns and the Jarque-Bera values are high and statistically significant for the three series. Moreover, we can detect the ARCH effect for all series by applying the ARCH test to detect the problems induced by heteroscedasticity. Furthermore, the distributions are fat-tailed because the excess kurtosis is positive. As a result, implementing the VAR(p)-BEKK-GARCH(1,1) model in our analysis appears to be suitable as it takes into account the time-varying volatility in clusters. Figure 2 and figure 3 also provide an evidence of a time varying volatility for both markets. Figure 4 and figure 5 depicts the volatility conditional variance for gold prices and stock markets, where we note an excess of volatility of gold prices, except at the beginning of 1968.

Figure. 2. Time evolution of real S&P 500 returns

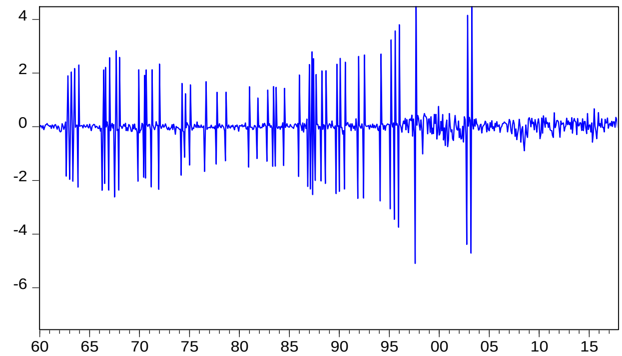


Figure. 3. Time evolution of gold real price returns

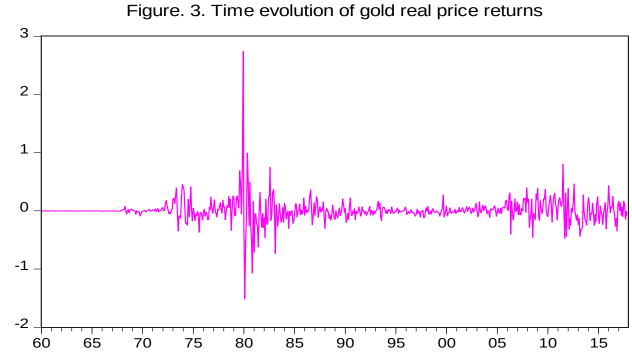


Figure. 4. Conditional variance gold returns

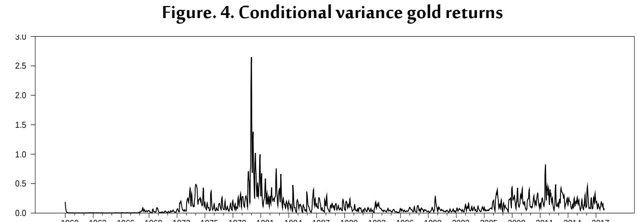


Figure. 5. Conditional variance S&P500 stock returns

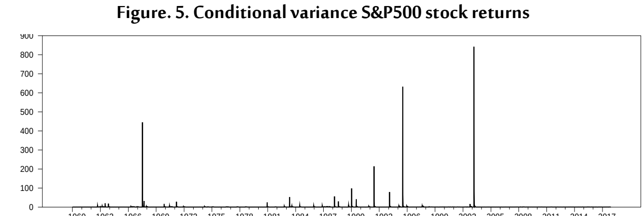


Table 2 provides the results of our model named as VAR-unrestricted BEKK-GARCH(1,1). Two variants of our model are used for estimation: in the first model the geopolitical risk index without lag is introduced, but in the second model, one-time lag retard is introduced in the same series. The ARCH test used to detect the problem of heteroscedasticity, and the null hypothesis is rejected. However, for the problem of autocorrelation, the null hypothesis is rejected, which means that autocorrelation is absent. A significant negative effect is detected from increased geopolitical risk index on gold markets. However, on stock market there is a negative effect but not significant. Indeed, the geopolitical instability such as, conflicts between countries, violence and other problems can affect the gold market especially in the producing regions. This result is in line with Triki (2018) when the quantile causality test is used to study the causality between these two series. Moreover, the absence of significant effect of GPR index on S&P 500 stock index can be interpreted as the absorption of any exogenous shocks by the stock market.

The direct effects of geopolitical risk (θ_{12}) on the time varying conditional covariance among stock market and gold market presented in the column three of the table 2 shows significant negative effects in the presence of a lagged GPR index (see coefficient on the chart), which leads to divergent benefits among two markets. In the case when the GPR index lagged by one period, a positive effect of the S&P500 is noticed but a weaker and negative effect of the gold yields is detected. This reduction in the statistically significant correlation between the two markets is explained by the move of investors from stock market to the gold market. However, the influences of indirect effects are positive. This can be interpreted as the results of an uncertainty of stock markets that affects the stock-gold covariance (see coefficient $\beta_{21}\beta_{22}$).

Table 2: VAR-BEKK-GARCH (1,1)-in-mean model estimation results.

	Variable	Model 1		Model 2	
		RWTI-RSP500		RWTI-RSP500	
		Coeff	p-value	Coeff	p-value
SP500 mean return equation	Const t	0.0083	0.070	-0.012	0.009
	RSP500t-1	0.972	0.000	0.896	0.000
	RSP500t-2	-0.353	0.000	-0.194	0.000
	RSP500t-3	0.207	0.000	-0.108	0.000
	RSP500t-4	-0.368	0.000	-0.093	0.000
	RSP500t-5	0.110	0.000	0.043	0.029
	RSP500t-6	0.062	0.005	0.092	0.000
	RSP500t-7	0.021	0.283	-0.013	0.348
	RSP500t-8	-0.077	0.000	0.026	0.478
	RGt-1	0.015	0.625	0.026	0.478
	RGt-2	-0.076	0.050	-0.023	0.049
	RGt-3	-0.043	0.461	0.152	0.003
	RGt-4	-0.079	0.267	-0.225	0.000
	RGt-5	0.045	0.424	0.102	0.100
	RGt-6	0.016	0.770	-0.065	0.395
	RGt-7	0.114	0.03	0.097	0.042
	RGt-8	-0.186	0.000	-0.052	0.009
	GPRt	-0.0046	0.324	----------	---------
	GPRt-1	------------	----------	-0.0025	0.026
mean equation	Const.	0.290	0.000	-0.0004	0.000
	RSP500t-1	0.00022	0.560	-0.0003	0.534
	RSP500t-2	-0.0003	0.690	0.00005	0.947
	RSP500t-3	-0.0009	0.041	-0.0008	0.010
	RSP500t-4	-0.0011	0.202	-0.0014	0.010
	RSP500t-5	0.0004	0.520	-0.00001	0.977
	RSP500t-6	-0.0005	0.409	-0.00022	0.746
	RSP500t-7	0.0004	0.572	-0.0007	0.0521
	RSP500t-8	0.00003	0.935	0.0006	0.075
	RGt-1	1.124	0.000	1.09	0.000
	RGt-2	-0288	0.000	-0.331	0.000
	RGt-3	-0.206	0.000	0.205	0.000
	RGt-4	-0.035	0.131	-0.415	0.000
	RGt-5	0.087	0.000	0.153	0.000
	RGt-6	0.200	0.000	0.197	0.000
	RGt-7	-0.303	0.000	0.057	0.020
	RGt-8	0.01	0.272	-0.286	0.0022
	GPRt	-0.0017	0.000	---------	--------
	GPRt-1	--------------	-------------	0.0012	0.31
Var-cov equations	c11	0.290	0.000	-0.144	0.000
	c21	0.005	0.000	-0.007	0.000
	c22	0.008	0.000	-0.005	0.000
	α11	1.064	0.000	1.461	0.000
	α12	-0.0007	0.333	-0.0006	0.566
	α21	0.129	0.548	0.475	0.000
	α22	1.539	0.000	1.383	0.000
	β11	0.644	0.000	0.326	0.000
	β12	0.00035	0.324	-0.00005	0.909
	β21	0.0823	0.0009	0.032	0.008
	β22	0.587	0.000	0.715	0.000
	κ11	-0.0019	0.000	---------	----------
	κ12	-0.0038	0.110	---------	----------
	κ22	-0.0016	0.060	---------	---------
	θ 11	-------	-----------	-0.0102	0.000
	θ12	-------	-----------	-0.0042	0.021
	θ22	-------	----------	-0.0015	0.423
	GED parameter	0.7126***		0.7152***	
	Log likelihood	4753.08077001		4727.77707977	

Figure 6 presents both the time evolution of geopolitical risk with the conditional correlation. The results of variance equation show that the stock market (β_{11}) is higher than the persistence volatility of gold market (β_{22}). Besides, it is clear that the impact of GPR index on gold variability is more substantial as compared to the stock market (compare the α_{11} to the α_{22} coefficients) involving different investment reactions in both the stock market and the gold market.

Figure. 6. geopolitical risk index vers us Conditional between real gold returns and real stock returns

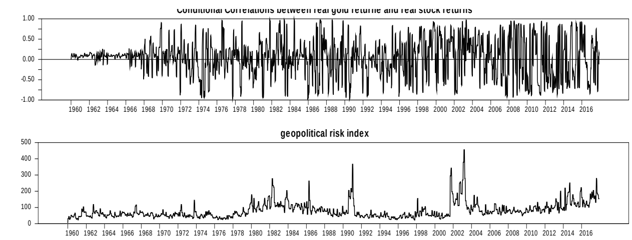


Table 3 reports the diagnostic tests of the two models based on standardized and squared standardized residuals. It shows that the two models are generally flexible enough to capture the dynamics of the conditional return, the volatility of the S&P500 and gold. It can be seen that the p-vakue of Ljung–Box statistics for the standardized and squared standardized residuals at 12 lags (Q(12) and Q2 (12)) indicate that heteroscedasticity and autocorrelation are not present with this type of models.

Table 3: Diagnostics Test

	Model 1		Model 2	
	RWTI-RSP500		RWTI-RSP500	
	Res. WTI eqn	Res. SP500 eqn	Res. WTI eqn	Res. SP500 eqn
Ljung-box Q(12) p-value	0.42	0.06	0.43	0.06
Ljung-box Q2(12) p-value	0.51	0.12	0.62	0.15
McLeod-Li(12) p-value	0.98	0.95	0.98	0.95
ARCH(4) test p-value	0.98	0.95	0.98	0.95

Note : ***denote significance at 1%.

5. Conclusion

This paper has been an attempt to re-explore the relationship between the gold prices and the stock market in global tension and conflict by introducing a new index calculated by Caldara and Iacoviello on 2016. The gold price, S&P500 index and geopolitical risk index are used for period from 1960 to 2017 in a VAR-BEKK-GARCH model to compute the mean returns and the variance-covariance. It was found that the geopolitical risk can affect the markets, correlation between markets and investor sentiment allocation. More precisely, the gold market appears to be more affected by friction, in terms of mean return and variability in contrast to the stock market index. Finally, conditional covariance among the two markets shows a statistically significant decrease with the presence of a time lag in the geopolitical risk index.

Our results show that gold volatility has a negative relationship with the volatility of the S&P500, especially during stressful periods, which leads to the conclusion that gold is an ideal investment for a portfolio due to its diversification properties. However, although gold can protect against a decline in the stock market, it could also significantly reduce the returns of the portfolio during periods of growth in the stock market. Furthermore, in the short term, there may be co-movements between gold and the stock market, because investors use the metal to free up cash, especially for profit taking. Therefore, holding gold in a portfolio seems to require rather active management than being a simple buy and hold, especially if this holding turns out to be a significant part of the portfolio.

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