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The Most Significant Factors Influencing the Price of Gold: An Empirical Analysis of the US Market

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Gold is always a precious metal for many hundred years. Semi flexible gold demand and supply chain determines international gold prices in the long term. USA is ranked the world's largest gold producer. This study mainly aims to investigate the dynamic factors which affect the price of gold and determine the essential macro-economic variable that has the most important role during the process. This paper examines USA over 13 years applying a formal test for time series, which interrogate cointegration relationships, what is the affiliation between gold price and other factors, which are explained in detail below. The present study has used the monthly data from January, 2003 to June, 2016. Databases are provided by the Federal Reserve, the central bank of the United States, and United States Energy Information Administration. Data analysis was performed with software package EViews 8. Through the time series, an analysis has been carried out on Dow Jones Index, the US exchange rate, silver price, interest rate, oil price and inflation rate which are thought to influence the price of gold in the most significant way. The data analysis includes the determination of the conditional heteroscedastic model to estimate volatility. Therefore, the best fitting model to the data set, which is the exponential GARCH model, is preferred. In accordance with the results of the empirical analyses in the USA, the highest negative correlation is found between gold prices and US exchange rate. Secondly, a positive correlation is found among gold prices, silver prices, and oil prices. Another point which takes attention as a result of the study is that economic and political structural breaks weighed heavily, traders and hedgers from all over the world were able to drive prices up to incredible highs. The added value of our study arises from the inclusion in the analysis of macro economic variables, which has proved to have crucial relevance for the price of gold in the context of the recent economic structure.

Keywords: economic growth, US market, traders and hedgers, gold prices, ARCH model, GARCH model

Introduction

Gold is one of the most malleable, ductile, dense, conductive, non-destructive, brilliant, and beautiful metals (Hauptfleisch, Putniņš, & Lucey, 2015). For many centuries, gold has maintained its purchasing power as an important saving and investment instrument. In the ancient times, gold formed the basis of the monetary system. At that time, it fixed US dollar and became a reserve instrument with the Bretton Woods System.

One of the characteristics that make gold so attractive to investors is its property. The precious metal tends to sustain its value over time. Many even say one ounce of gold buys the same amount of bread, as it did at any

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time throughout history. For many years strengthened gold prices in combination with US dollar (USD) depreciation have attracted the attention of investors, risk managers and the financial media (Reboredo, 2013).

Gold has become a hot and popular investment opportunity in the last few years, and more and more people are seriously considering making gold a part of their portfolio.

There are various studies analyzing the correlation between the price of gold and some economic variables. The main motivation behind these studies is to reveal whether macro economic factors have an impact on the price of gold and determine dynamic effects in which these factors hit with force.

The rest of the present paper is organized as follows: Section 2 is devoted to literature review. Section 3, 4, and 5 discuss the empirical methodology and findings, describing the data and their characteristics and present the results. Section 6 provides a brief conclusion.

Literature Review

There has been much academic research on economic issues related to any of the practical uses for gold.

Batchelor and Gulley (1995) conducted a study on the relationship between jewelry demand in a number of countries (USA, Japan, Germany, France, Italy, and the UK) and the price of gold. S. Selvanathan and E. A. Selvanathan (1999) discussed recent evidences on the issue through an empirical test on the Western Australian gold production between 1948 and 1994. They explored a positive relationship of price. Bertus and Stanhouse (2001) evaluated gold prices in terms of supply and demand factors. They found that the relationship between gold prices and mining activities is then a factor to be considered in the model. According to the study of Moel and Tufano (2002), the opening and closing of mines are conditional on the consistency of gold price with the "real option" embedded characteristic in gold mines as analyzed theoretically. They found that as prices rise miners tend to mine lower quality. Xu and Fung (2005) examined the US and Japanese daily trading in gold and also in silver and platinum. They used the 1994 and 2001 data and argued that Japanese market leads. Starr and Tran (2008) provided an analysis affecting the physical demand for gold in 1992 and 2003. The results of their study showed a significant heterogeneity between the drivers of demand in different countries as might be expected. Soytas, Ramazan, Shawkat, and Erk (2009) discussed gold prices in Turkish Lira and their domestic exchange rate. They found the gold price to be highly inelastic related to the value of Turkish Lira and argued that, in the long term, it seems to be more warrantable, defining it as a safe harbour. Ivanov (2011) analyzed the influence of Gold and Silver Exchange Traded Funds on price discovery in the future market. The results have showed that the creation of ETF has decreased the importance of futures with now ETF's leading price discovery for both markets. Chng and Foster (2012) examined the convenient yield of all four precious (gold, silver, platinium, and palladium) metals. They find that yield of gold and silver returns both have significant effects on platinum and palladium returns. Coleman and Dark (2012) compared investors and hedgers investments in the gold market. Study findings show us that investors are main drivers of gold price, rather than hedgers. Reboredo (2013) reassesses this issue confirming gold's ability to hedge US dollar risk. Reboredo's study shows that in the currency portfolios based on dollars gold acts to reduce value at risk and expected shortfall. A study by Lucey et al. (2015) examined two of the largest centers for gold trading—"London Fixings" and "COMEX futures prices", trying to answer how different geographical markets of gold trading contributed to the profit. Consequently, they found that these centers contribute to price discovery dominating the process at different times with no obvious macroeconomic or political links. Lucey et al. (2015) expanded the research by growing the number of the markets examined in 2013. In keeping with earlier findings, London

and New York are found to be consistently dominant as the drivers of returns and volatility in the four markets throughout the sample, with each taking a leading role at different times. Sensoy, Hacihasanoglu, and Nguyen (2015) examined the overflow between oil and gold futures. Their results point out a convergence of spillover effects. Hauptfleisch, Putniņš, and Lucey (2015) measured information transmission in London and New York. They concluded that both New York and London contribute to global price transfer of information, where London is believed to be more dominant.

At the end of the Bretton Woods system in 1971 and the transition of the USA from a gold to currency led to an increased academic and professional interest in role of gold in financial markets. There is a large and growing literature on gold. This review endeavours to adduce this literature, in particular as it applies to gold as an investment asset, and to point out whether gold, which is a popular saving instrument is a safety harbour or not.

In the survey carried out to determine the factors effecting the price of gold in US Market with using specific six economic variables, the last sentence is distinguished from the other papers.

Research Methods

The present study aims to examine the factors affecting the price of gold. The variables are used from the period January 2003 to June 2016. The latest version of the database was updated in June 2016. The study intends to determine whether there is a correlation between the growth in macroeconomic variables and the change in gold price. Time series databases are obtained from Federal Reserve, the Central Bank of the United States, and United States Energy Information Administration.

In this study, EViews 8 econometrics software package has been used to determine the time-series properties of the data related to the variables.

Detailed description of the variables and parameters used in the model and their symbols is shown in Table 1.

Table 1

Used Data Set in the Model

Variable	Description	Explanation
GOLD	Gold price	1 ounce of gold is equivalent in the London gold market
OIL	Oil price	Brent oil price is denominated in US dollars for barrel
SLVR	Silver price	1 ounce of silver is equivalent in the London silver market
USD	USD currency	Major Currency Dollar Index
DJIA	Dow Jones Industrial Average Index	Dow Jones Industrial Average is a price-weighted average of 30 significant stocks traded on the New York Stock Exchange and Nasdaq.
INT	Interest Rate	US Real Fed Funds Rate
CPI	Inflation Rate	US Consumer Price Inflation Rate

Research Results

The great workhorse of applied econometrics is the least squares model. This is natural because applied econometricians are typically called upon to determine how much one variable will change in response to a change in some other variables. Increasingly however, econometricians are being asked to forecast and analyze the size of the errors of the model. In this case the questions about volatility and the standard tools have become the ARCH/GARCH models (Engle, 2001).

An ARCH (autoregressive conditionally heteroscedastic) model is a variance of a time series. ARCH models are used to define a changing, possibly volatile variance.

An ARCH(m) process is in which the variance at time is conditional on observations at the previous times, and the relationship is:

$$\mathrm{Var}(y_t|y_{t-1},\ldots,y_{t-m}) = \sigma_{2t} = \alpha_0 + \alpha_1 y_{2t-1} + \ldots + \alpha_m y_{2t-m}. \; \mathrm{Var}(y_t|y_{t-1},\ldots,y_{t-m}) = \sigma_t^2 = \alpha_0 + \alpha_1 y_{(t-1)}^2 + \ldots + \alpha_m y_{(t-m)}^2$$

With certain constraints imposed on the coefficients, the y_t series squared will theoretically be AR(m).

A GARCH (generalized autoregressive conditionally heteroscedastic) model uses values of the past squared observations and past variances to model the variance at time t. As an example, a GARCH(1,1) is

$$\sigma_{2t} = \alpha_0 + \alpha_1 y_{2t-1} + \beta_1 \sigma_{2t-1} \sigma_t^2 = \alpha_0 + \alpha_1 y_{(t-1)}^2 + \beta_1 \sigma_{(t-1)}^2$$

In the GARCH notation, the first subscript refers to the order of the y^2 terms on the right side, and the second subscript refers to the order of the σ^2 terms.

To set up GARCH 2 model discussed in this articleis constructed by 2 ARCH effects excluding GARCH effect.

Table 2

Descriptive Statistics

	GOLD	OIL	SLVR	USD	DJIA	INT	CPI
Mean	982.7237	74.80247	16.86420	84.53086	12,472.74	1.302469	215.2593
Median	1,020.370	70.50000	16.00000	83.00000	12,000.50	0.000000	217.0000
Maximum	1,766.000	140.0000	49.00000	100.0000	20,275.00	5.000000	241.0000
Minimum	321.4000	19.00000	4.000000	72.00000	3,026.000	0.000000	182.0000
Std. Dev.	432.2727	29.69594	9.079707	7.116749	3,013.332	1.835094	17.68164
Skewness	0.054464	0.050032	0.909203	0.508171	0.354363	1.115605	-0.322692
Kurtosis	1.810854	1.870058	3.507670	2.440473	2.706025	2.677929	1.864844
Jarque Bera	9.625057	8.685769	24.05921	9.085634	3.973819	34.30370	11.50942
Probability	0.008127	0.012999	0.000006	0.010643	0.137119	0.000000	0.003168

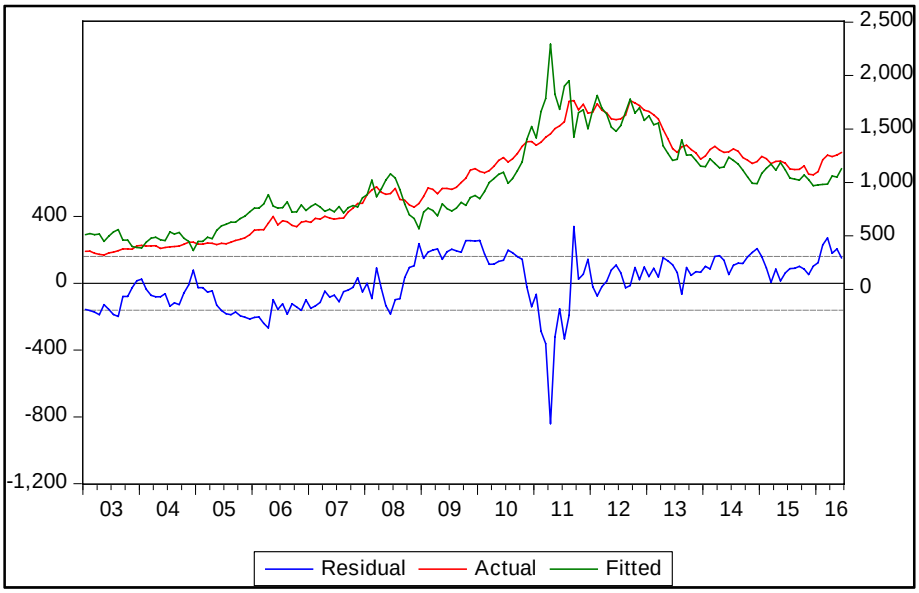

Figure 1. Residual values.

The residual values indicate that it can easily run ARCH model or GARCH model, because there is clustering volatility in the residual at the same time. There is ARCH effect, so it has all the validity to run ARCH or GARCH model.

Table 3

ARCH Test Results

F-statistic	16.31279	Prob. F(1,159)		0.0001
Obs*R-squared	14.98099	Prob. Chi-Square(1)		0.0001
Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	17,441.15	4,813.846	3.623121	0.0004
RESID^2(-1)	0.305042	0.075526	4.038910	0.0001

Table 4

GARCH Model Results

GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*RESID(-2)^2 + C(8)*DJIA + C(9) *INT + C(10)*CPI				
Variable	Coefficient	Std. error	Z-statistic	Prob.
C	-1,737.789	151.6182	-11.46161	0.0000
OIL	3.020260	0.603642	5.003397	0.0000
SLVR	48.96444	1.703029	28.75138	0.0000
USD	20.00617	1.504765	13.29521	0.0000
		Variance equation		
C	-1,835.416	14,177.57	-0.129459	0.8970
RESID(-1)^2	0.935994	0.329128	2.843861	0.0045
RESID(-2)^2	0.050207	0.155132	0.323640	0.7462
DJIA	-0.752092	0.480808	-1.564225	0.1178
INT	-53.74532	612.8847	-0.087692	0.9301
CPI	66.87242	80.55012	0.830196	0.4064
T-DIST. DOF	51,542.28	3.30E+08	0.000156	0.9999

Table 5

Wald Test Results

Test statistic	Value	df	Probability
F-statistic	7.601452	(2, 151)	0.0007
Chi-square	15.20290	2	0.0005
Null hypothesis: C(6) = C(7) = 0			
Null hypothesis summary:			
Normalized restriction (= 0)		Value	Std. Err.
C(6)		0.935994	0.329128
C(7)		0.050207	0.155132

Note. Restrictions are linear in coefficients.

Null hypothesis: C(6) = C(7) = 0. It means, C(6) and C(7) jointly can not influence depending variable which is Gold. The null hypotesis can be rejected. The results show us, they can jointly influence the gold price volatility.

Table 6

ARCH Test Results

F-statistic	0.117128	Prob. F(1,159)		0.7326
Obs*R-squared	0.118514	Prob. Chi-Square(1)		0.7307
Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	1.028134	0.114336	8.992220	0.0000
WGT_RESID^2(-1)	-0.027179	0.079414	-0.342239	0.7326

According to the results, there is no ARCH effect.

Table 7

ARCH LM Test Results

Autocorrelation	Partial correlation		AC	PAC	Q-stat	Prob
.|. |	.|. |	1	-0.027	-0.027	0.1210	0.728
.|. |	.|. |	2	0.039	0.038	0.3706	0.831
.|. |	.|. |	3	-0.020	-0.018	0.4360	0.933
.|. |	.|. |	4	-0.029	-0.032	0.5821	0.965
.|. |	.|. |	5	0.057	0.057	1.1298	0.951
*|. |	*|. |	6	-0.073	-0.068	2.0332	0.917
.|. |	.|. |	7	0.067	0.059	2.8082	0.902
*|. |	*|. |	8	-0.078	-0.069	3.8469	0.871
.|. |	.|. |	9	-0.014	-0.021	3.8798	0.919
.|. |	.|. |	10	-0.006	-0.006	3.8852	0.952
.|. |	.|. |	11	-0.027	-0.018	4.0118	0.970
*|. |	*|. |	12	-0.089	-0.107	5.4037	0.943
.|. |	.|. |	13	-0.043	-0.030	5.7334	0.955
.|. |	.|. |	14	-0.052	-0.063	6.2201	0.961
.|. |	.|. |	15	-0.016	-0.015	6.2678	0.975
.|. |	.|. |	16	0.068	0.063	7.1027	0.971
*|. |	*|. |	17	-0.076	-0.075	8.1545	0.963
.|. |	.|. |	18	-0.005	-0.025	8.1591	0.976
.|. |	.|. |	19	0.027	0.044	8.2923	0.983
.|. |	.|. |	20	-0.017	-0.034	8.3447	0.989
.|. |	*|. |	21	-0.060	-0.083	9.0319	0.989
*|. |	*|. |	22	-0.126	-0.124	12.025	0.957
.|. |	.|. |	23	0.049	0.022	12.483	0.962
.|. |	.|. |	24	-0.054	-0.053	13.050	0.965
.|. |	.|. |	25	0.065	0.042	13.859	0.964
.|* |	.|* |	26	0.128	0.114	17.050	0.908
*|. |	*|. |	27	-0.072	-0.071	18.066	0.902
.|. |	.|. |	28	0.014	-0.008	18.103	0.924
.|. |	.|. |	29	0.001	0.019	18.103	0.942
.|. |	*|. |	30	-0.056	-0.103	18.743	0.945
.|. |	.|. |	31	-0.041	-0.058	19.087	0.953
.|. |	.|. |	32	-0.024	-0.025	19.201	0.964
.|. |	.|. |	33	0.036	0.004	19.470	0.970
.|. |	.|. |	34	0.049	0.046	19.972	0.973
.|. |	.|. |	35	0.008	-0.008	19.986	0.980
.|. |	.|. |	36	-0.012	-0.042	20.017	0.986

Probability values more than 5%. This model is free from serial correlation.

Discussion

Research findings:

(1) There is no ARCH effect.

(2) This model has no serial correlation.

(3) ARCH 1 and ARCH 2 are significant.

It seems:

Internal shock: OIL, SLVR, and USD, can influence the volatility gold price.

External shock: DJIA, INT, and CPI, can not influence the volatility of gold.

Conclusion

Especially in the last decade, owing to economic instabilities and fragility in global economies, properties markets have showed high volatility. Gold market has become a close-up followed market by industrialized economies and emerging economies. Consequently, gold price volatility can be an instrumental explanatory variable for macroeconomic stability of countries. This paper investigates the dynamic effects of gold price volatility on the rates of growth in world economies.

An empirical evidence is examined determination of factors affecting the price of gold in the United States fom January 2003 to June 2016. Macro variables affecting the price of gold, Dow Jones Index, the US exchange rate, silver price, interest rate, oil price, and inflation rates have been used for this research. The empirical methodology of the study is based on an emprical study. The part includes the determination of the conditional heteroscedastic model to estimate volatility. Therefore, we prefer the best fitting model to the prefered data set, which is the exponential GARCH model.

According to the analysis of the results, the econometric model confirms the analogous findings reported by other studies and growth in economic activity tends to lead a decrease in volatility. The obtained results are analyzed and it demonstrated that there is a significant linear relationship and a negative correlation among a return of gold, return of dollar, oil price, and silver price. No significant linear relationship has been detected among the other variables and price of gold.

While Dow Jones Index, the US exchange rate, silver price, interest rate, oil price, inflation demand, and gold's safe haven status have played a role in gold prices. It was the speculators' rise to power that has an increasing amount of influence on gold prices. As economic and political structural breaks weighed heavily, traders and hedgers from all over the world were able to drive prices up to incredible highs.

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