

Analysis of the Correlation between Gold-Oil Ratio and Capital Market

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Abstract. Based on the phenomenon that the ratio of gold to oil soared to 200, this paper selects the CSI 300 index and the S&P 500 index as the representatives of the Chinese and American capital markets, respectively. Specifically, VAR model is used for empirical analysis. Through unit root test, confirmation of lag order, impulse response analysis and Granger causality test, it is concluded that there exists a correlation between gold-oil price and Chinese and American capital markets. At the same time, the fluctuation of gold - oil price has a hysteretic effect on Chinese and American capital markets. Therefore, investors can predict the risks of the capital market according to the fluctuation of the ratio of gold to oil, so as to formulate or change the investment strategy to reasonably avoid risks.

Keywords: Gold-oil ratio; CSI 300; S&P 500; VAR.

1. Introduction

The gold-oil ratio refers to the ratio obtained by comparing the price of gold per ounce with the price of crude oil per barrel. It is an important reference index used internationally to observe the relationship between gold and crude oil and predict the change of global risk structure. At the same time, as a daily data, gold-oil ratio can reflect changes in the economic situation faster. So many investors regard it as a leading indicator of changes in the economic situation.

According to historical data, the gold-oil ratio has successfully predicted economic crises more than once. On April 21, 2020, the gold-oil ratio soared above 200. On the same trading day, the global stock and commodity markets experienced sharp fluctuations, and the subsequent global economic downturn also confirmed this statement.

The main reason why the gold-oil ratio can be used to predict the change of economic situation is that it reveals the change of market risk structure to a certain extent. Gold and crude oil are both commodities, and their price trends are consistent in the long run. When the economy is in a steady state, if the rise in oil prices leads to inflation, then the rise in gold prices; Similarly, when oil prices fall, gold prices fall. So, the gold-oil ratio is relatively stable under normal circumstances. Once the gold-oil ratio changes beyond the normal range, it indicates that the market risk structure may change, or the related policy uncertainty increases.

According to the above analysis, it can be concluded that there is a strong correlation between the gold-oil ratio and the capital market. Therefore, this paper mainly verifies this conclusion through empirical analysis.

2. Literature Review

Li extended to the impact of commodities on the stock market. It used theories to lay the foundation for the conclusion, and then conducted empirical analysis by constructing Vector autoregressive model (VAR) and generalized autoregressive conditional heteroskedasticity (GARCH) model to support the theoretical research with data [1]. Based on the phenomenon that the gold-oil ratio soared to 200, Jiang used the VAR model to study the co-movement of the gold-oil ratio and the Chinese and American capital markets. At the same time, Jiang selected the CSI 300 and the S&P 500 index as the representatives of the Chinese and American capital markets. Finally, it is proved that the gold-oil ratio and the volatility of the capital market are co-related. And the conclusion is drawn that China's capital market is more likely to be affected by the gold-oil ratio [2]. Besides, Gao and Yang

also chose to use VAR model construction for empirical analysis [3]. In addition, the gold-oil ratio mentioned in Guo 's report in 2023 had broken through the normal range of variation. And the global economy was in an unstable period, which further verified Jiang's conclusion [4].

By analyzing the commodity characteristics of gold and crude oil, Shi and Li also concluded that the fluctuation of the gold-oil ratio was due to the change of the capital market. Then it explained the correlation between the gold-oil ratio and the capital market through the listing of historical data [5]. Wen and Li chose a research method different from the above scholars. By studying the impact of gold, crude oil and copper on global CPI and GDP of major countries. It inferred the impact of gold-oil ratio and copper-oil ratio on the economic trend and conducted data support through data of different periods [6]. Cheng also believed that compared with other news and policies, the volatility of the gold-oil ratio can more directly and quickly show the changes in the market [7].

Baur selected the data of stock index return rate and gold return rate of 13 major countries in the world. Then it analyzed the impact of gold return rate on the stock indexes of these 13 countries through GARCH daily model and unsymmetrical GARCH model. It found that in the mature European and American developed markets, gold had become the main hedging channel when the securities market was depressed [8]. Frank and David studied the long-term dynamic relationship between commodity prices, CPI and money supply in the United States. By constructing VAR models of the three, they believed that international commodity prices were directly proportional to CPr and money supply in the United States [9]. K.S. Sujit selected the daily data of gold price, oil price, US dollar exchange rate and stock return from 1998 to 2011 as the research object. And it verified the dynamic relationship among gold price, stock return, US dollar exchange rate and oil price by using time series method. The results showed that the correlation between gold price and the trend of US dollar is strong, while the correlation between stock market and gold price is weak [10].

3. Data Analysis

This paper selects the gold and crude oil prices in the ten years from 2012 to 2021. And it calculates the corresponding gold-oil ratio each year.

It can be intuitively seen from Fig. 1 that the crude oil price has been on a downward trend in the past decade, during which there was a sharp decline in 2014 and then the crude oil price has remained at a lower level than before 2014. From 2015 to 2021, the crude oil price fluctuated slightly within a certain range, and the overall price was relatively stable. It is known that supply and demand affect commodity prices, so the collapse of prices in 2014 should be due to the oversupply in theory, leading to such a sharp decline. From the perspective of market factors, the main reason is that the supply of crude oil is sufficient due to the non-production reduction of OPEC, the continuous increase of the production of shale oil and gas in the United States. The supply of crude oil in the market is far greater than the demand, resulting in the decline of the oil price. In terms of non-market factors, oil prices are also affected by geopolitical factors, dollar liquidity and dollar movements and financial speculation. Both market and non-market factors act on the price of oil and influence its direction. From the above analysis, it can be concluded that the collapse of oil price is the result of artificial manipulation of oil price by financial speculative forces under the condition of oversupply of crude oil.

Compared with the changes in crude oil prices in the past decade, gold prices have fluctuated more steadily. The lowest point for gold prices also came in 2014. Before 2014, gold price showed a downward trend, and then the price gradually recovered. In 2012, the global economy began to recover slowly after the impact of the economic crisis. The loose monetary policy and the decrease of the demand for safe haven in the economic recovery led to the fluctuation of the gold price in the high range in 2012. Gold prices have continued to fall in 2013, largely because the market has marked down inflation expectations in the medium term. Meanwhile, in recent years, quantitative easing policies in developed countries have led to massive liquidity injection around the world. However, this policy did not promote significant growth of developed economies, nor did it push up global

inflation, but led investors to lower inflation expectations. At the same time, expectations of a stronger dollar have led to weaker gold prices and hot stock markets around the world, providing attractive alternatives for gold investors. In 2014, influenced by the gradual reduction of quantitative easing policy in the United States, the continued low global inflation data, the European Central Bank's interest rate cut to support the economy, the global gold price kept low. On October 30, 2014, the Federal Reserve announced the end of QE3. With the gradual strengthening of the US dollar and the recovery of the global economy, the investment demand for gold fluctuated. With the recovery of the US economy and the interest rate hike policy of the Federal Reserve, the gold price gradually began to recover.

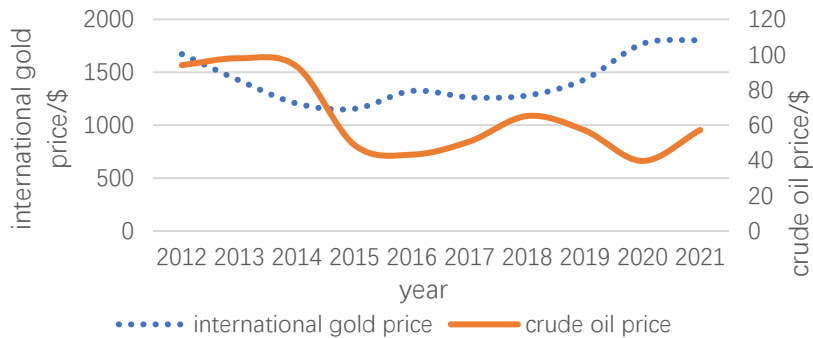


Fig. 1 The price of gold and crude oil in recent 10 years

When the economic situation is stable, the gold-oil ratio generally fluctuates around 16 and does not exceed 25. Once the ratio breaks through this range, it indicates that the economic situation will fluctuate greatly. As can be seen from Fig. 2, the gold-oil ratio broke out of the normal fluctuation range in four of the last ten years. Just as the above analysis of gold and crude oil prices, the main reasons why the gold-oil ratio broke the normal range in 2014 were the oversupply of crude oil and the impact of economic policy changes on gold prices. In 2016, crude oil prices were low, but gold prices remained largely stable, resulting in a high gold oil ratio. In 2020, crude oil prices fell again due to the impact of the COVID-19 pandemic. The gold price soared, and the gold-oil ratio hit a record high as investors piled into inflation-fighting commodities like gold to reduce their risk during the pandemic because they were pessimistic about the economy.

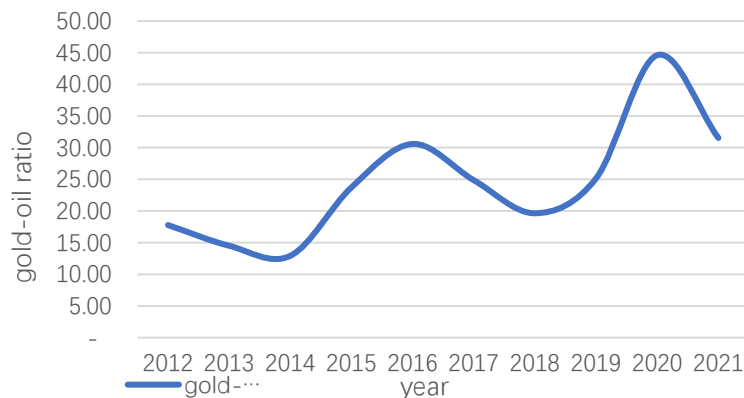


Fig. 2 Gold-oil Ratio

It is not difficult to see from the analysis of the above two figures that the abnormal gold-oil ratio is almost always accompanied by the abnormal fluctuations of the global economy. So, it can be concluded that the gold-oil ratio is closely related to the changes of the capital market.

The change of the capital market is affected by many factors. This paper selects the most representative CSI 300 and S&P 500 and calculates the volatility of the return rate. Then it calculates

the return rate of three cycle data series respectively according to the logarithmic return rate formula (1), which is denoting as {GOR}, {HS300} and {BP500}.

$$R_t = [\ln(pt) - \ln(pt - 1)] \times 100\% \quad (1)$$

Using these three-cycle data, a three-way VAR (p) model is constructed to study the co-movement of "gold-oil ratio", Chinese capital market and American capital market. The general form of the mathematical expression of this model is formula (2).

$$y_{it} = \alpha_{i0} + \alpha_{i1}y_{1,t-1} + \dots + \alpha_{ip}y_{1,t-p} + \beta_{i0} + \beta_{i1}y_{2,t-1} + \dots + \beta_{ip}y_{2,t-p} + \gamma_{i0} + \gamma_{i1}y_{3,t-1} + \dots + \gamma_{ip}y_{3,t-p} + \varepsilon_{it} \quad (2)$$

Where, y_{it} represents the value of the t th of the I th dependent variable, all of which are parameters to be estimated (α represents the influence of the first variable, β represents the influence of the second variable, and γ represents the influence of the third variable). p is the undetermined lag order, and ε is random white noise. Descriptive statistics of the variables are shown in Table 1.

Table 1. Basic statistical characteristics of rate of return series

	Average	Standard Deviation	Skewness	Kurtosis	J-B(p)
GOR	0.2168	6.6793	3.1759	54.4004	63258.7***
HS300	0.0929	1.9354	-0.8577	6.6605	385.3836***
BP500	0.2041	2.2909	-1.1022	11.0043	1609.408***

4. Empirical Analysis

In order to avoid the phenomenon of pseudo-regression, it is necessary to conduct stationarity test on the sequences. This paper adopts ADF method to conduct unit root test on GOR, HS300 and BP500 respectively, and finds that all three are stationary sequences with no intercept term and no trend term. Then check the p value corresponding to the t statistic in the case of None (Table 2). The final conclusion shows that when the significance level is 1%, the three sequences all reject the original hypothesis of the existence of unit root process, so the constructed return sequence is stable.

Table 2. Unit root test of return series

	Unit root form	AIC	SC	HQ	t value
GOR	Constant & Trend	6.6178	6.6409	6.6268	-20.072***
	Constant	6.6145	6.6299	6.6205	
	None	6.6116*	6.6193*	6.6146*	
HS300	Constant & Trend	4.1431	4.1661	4.1521	-20.381***
	Constant	4.1399	4.1553	4.1459	
	None	4.1379*	4.1456*	4.1409*	
BP500	Constant & Trend	4.4960	4.5190	4.5050	-25.946***
	Constant	4.4930	4.5084	4.4990*	
	None	4.4919*	4.5068*	4.5021	

In the construction of VAR model, the optimal lag order is first determined, and then the Granger causality analysis, impulse response analysis and variance decomposition analysis are carried out.

First, it is necessary to determine the order of lag. The Lag Length Criteria method provided by Eviews software is used to determine the optimal order of lag, and the test order is selected as 8 order (Table 3). The observation of the table showed that FPE and AIC showed the optimal order of delay after 4, LR showed the optimal order of delay after 5, and SC showed the optimal order of delay after 0. HQ test shows that the first lag period is the best, according to the principle of * maximum, so the

lag period 4 is selected as the best lag period, that is, p is equal to 4. The three-element VAR(4) model needs to be constructed in this paper.

Table 3. VAR model lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4263.32	NA	878.1811	15.29148	15.31473*	15.30056
1	-4235.11	56.01655	819.7495	15.22263	15.31563	15.25895*
2	-4226.79	16.4347	821.7474	15.22506	15.3878	15.28862
3	-4219.66	14.00609	827.2774	15.23176	15.46425	15.32256
4	-4205.05	28.53885	810.8208*	15.21165*	15.51389	15.32969
5	-4196.33	16.94424*	811.6462	15.21265	15.58464	15.35792
6	-4189.61	12.98599	818.3268	15.22081	15.66255	15.39333
7	-4182.23	14.17224	823.137	15.22663	15.73811	15.42638
8	-4175.47	12.92221	829.8076	15.23464	15.81588	15.46164

On the basis of determining the ternary VAR (4) model with a lag length of 4 orders, Granger test is carried out on it, as shown in Table 4. The results showed that BP500 had a significant influence on GOR at 1% significant water level. It can be considered that the S&P 500 shock is the Granger reason for the volatility of the "gold-oil ratio"; The impact of GOR on HS300 can be considered as the Granger cause of HS300. So according to the volatility of the gold - oil ratio, investors can effectively avoid investment risk.

Table 4. Granger causality test

Dependent Variable	Excluded	Chi-sq	df	p value
GOR	BP500	22.2573	4	0.0002
	HS300	3.7315	4	0.4436
	All	56.54115	8	0.0004
BP500	GOR	20.50485	4	0.5589
	HS300	8.934179	4	0.0535
	All	32.76795	8	0.1135
HS300	GOR	11.97879	4	0.0013
	BP500	5.549889	4	0.8906
	All	17.99456	8	0.0151

The stability of ternary VAR (4) model is analyzed by AR root test (Fig. 3). It is found that all the characteristic roots fall within the unit circle, indicating that the model is stable and can be analyzed by impulse response.

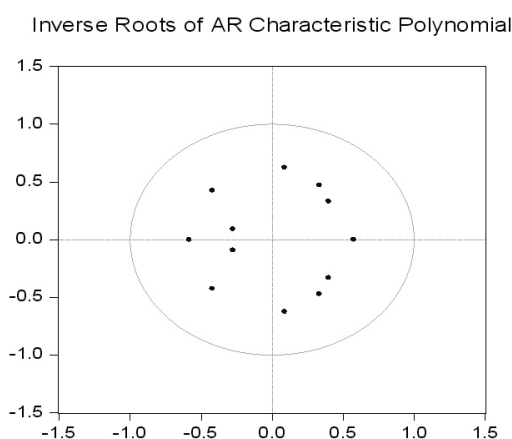


Fig. 3 AR root tests the stability of VAR model

According to the image of impulse response function, it can be found that the impact of three variables on the body is positive at the beginning of the period, and then decreases rapidly, and then fluctuates in a narrow range around the zero axis and tends to be stable in the sixth period (See Fig. 4). From the impact response analysis of BP500 in the first line, the impact of GOR increases positively in the first three stages, that is, the greater the fluctuation of GOR, the greater the corresponding fluctuation of BP500. In the following two reverses, and finally tends to be stable in the seventh stage. The impact phase of HS300 is almost consistent with the trend of the former, but its impact time is longer and tends to be stable in the 10th stage. As can be seen from HS300 in the second line, the impact of BP500 converges negatively in the early stage, that is, the greater the fluctuation of BP500, the smaller the wave movement of HS300, the smaller the wave dynamic impact in the later stage, and tends to be stable in the 10th stage, while the impact of GOR increases positively at the beginning. It stabilized in phase 9, indicating that the lag effect of the gold oil ratio on the Chinese capital market was greater than that on the American market. It can be seen from the GOR of the third line that it is first positive under the impact of HS300, inversely in the 4th stage, and is stable in the 9th stage, while the influence of BP500 is just the opposite, and becomes stable in the 7th stage. Because of this, it can be proved that the interaction of GOR, BP500 and HS300 exists. The conclusion can be drawn from the impulse response function that the volatility of China's capital market is mainly affected by its own volatility, which weakens gradually. At the same time, it is also affected by the "gold-oil ratio" and the American capital market, and the "gold-oil ratio" has a mainly positive effect on the volatility of China's capital market.

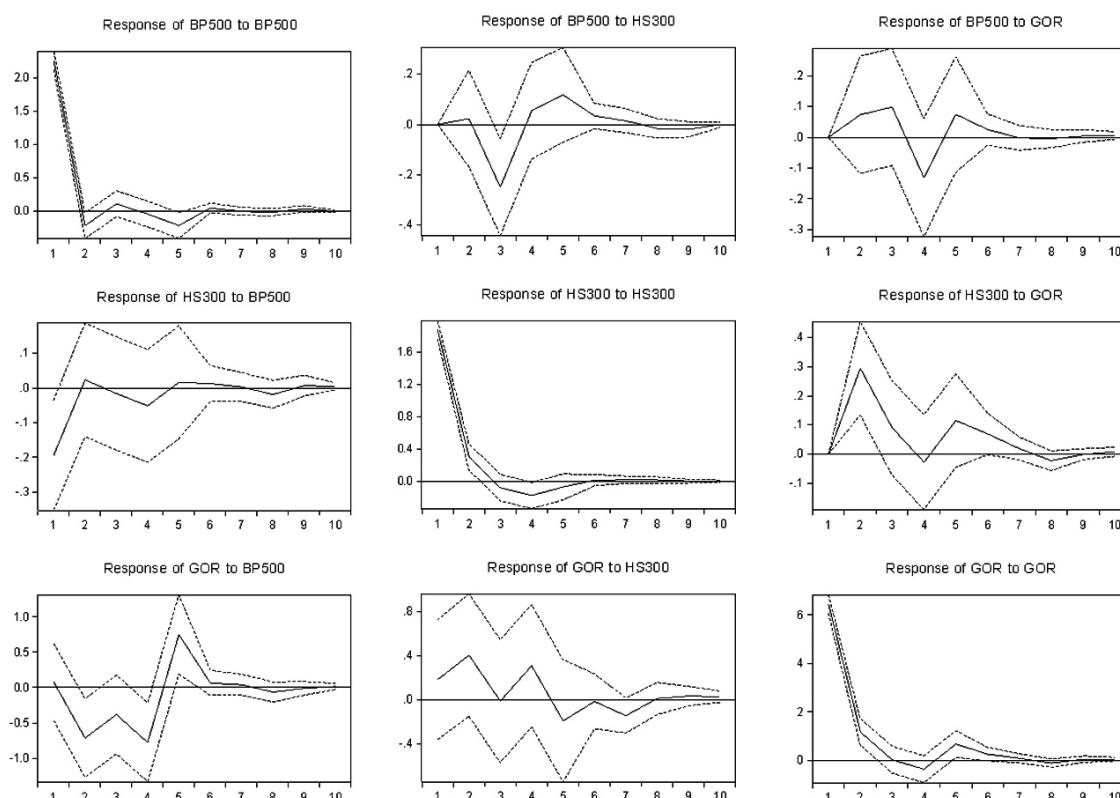


Fig. 4 Impulse response function

In order to further measure the lag effect of variable impact, this paper adopts the square difference method to decompose the endogenous variable fluctuation in the three-element VAR (4) model into the impact of different factors and adopts the decomposition model of the lag 8 stage. The three sequences are decomposed separately. It can be seen from Table 5 that BP500 square difference solution results can be seen that BP500 index is greatly affected by its own fluctuation, and is almost unaffected by HS300 and GOR, and its body shows that it is mainly affected by its own disturbance.

It is mutually verified with the above Granger causality analysis conclusion that the US capital market plays a pivotal role in the global economy, and its slight fluctuation will cause the continuous turbulence of the global capital market. Besides, its own independence is strong, and it is not easily affected by other indexes.

As can be seen from Table 6, the variance decomposition result of HS300 can be seen that it is mainly disturbed by its own factors, and it is enhanced by the influence of BP500 and GOR over time. At the same time, it can be considered that the shadow of GOR is larger than that of BP500 in the same period, indicating that HS300 is more susceptible to the fluctuations of GOR.

It can be seen from Table 7 that the square difference resolution results of GOR can be seen that the influence of BP500 and HS300 increases with time, but the influence of BP500 is much larger than that of HS300. It shows that GOR is more susceptible to BP500 fluctuations, and the influence of BP500 has a certain degree of lag.

Table 5. BP500 Variance decomposition

Period	S.E.	BP500	HS300	GOR
1	2.26402	100	0	0
2	2.27613	99.8845	0.0112	0.10435
3	2.29442	98.5189	1.19408	0.28699
4	2.29928	98.1444	1.24688	0.60872
5	2.31392	97.8-47	1.49051	0.7048
6	2.31472	97.7729	1.51111	0.71604
7	2.31478	97.7688	1.51512	0.71607
8	2.3149	97.7642	1.51954	0.71631

Table 6. HS300 Variance decomposition

Period	S.E.	BP500	HS300	GOR
1	2.264021	1.056822	98.94318	0
2	2.276127	1.021912	96.66608	2.312003
3	2.294421	1.02435	96.45317	2.522476
4	2.299279	1.084556	96.39645	2.518993
5	2.31392	1.086265	96.0587	2.855032
6	2.314717	1.089223	95.93318	2.977602
7	2.314777	1.089258	95.92393	2.986809
8	2.3149	1.097834	95.90252	2.999648

Table 7. GOR Variance decomposition

Period	S.E.	BP500	HS300	GOR
1	2.264021	0.014951	0.077292	99.90776
2	2.276127	1.179015	0.444712	98.37627
3	2.294421	1.504358	0.443757	98.05189
4	2.299279	2.828004	0.644701	96.52729
5	2.31392	3.997288	0.712491	95.29022
6	2.314717	4.000504	0.712083	95.28741
7	2.314777	4.001365	0.758931	95.2397
8	2.3149	4.008187	0.758814	95.233

From the results of variance decomposition, the impact of the ratio of gold to oil on the Chinese and American capital markets cannot be ignored. Meanwhile, there is a certain lag in the impact, and it will take a certain time to be reflected in the capital market. This indicates that the ratio of gold to

oil has certain foresight for the risk prediction of the Chinese and American capital markets and can help investors to predict the risk.

5. Conclusion

The American economy, the Chinese economy and the Gold-oil ratio are important indicators for the whole world. From the investigation in this paper, it can be found that the fluctuation data among the three are correlated, which all reflect the influence of two-way system. From the perspective of the American capital market, through the empirical analysis, the American capital market is the Granger cause of the gold-oil ratio. From the perspective of Chinese capital market, through Granger test, it is found that gold oil ratio is the Granger reason of Chinese capital market. Furthermore, through the analysis of impulse response function, it showed that although the gold-oil ratio also aggravates the volatility of China's capital market in the first several lag periods, the final volatility tends to be stable with the extension of lag periods. From the variance decomposition, it can be found that although the gold-oil ratio has an impact on the volatility of China's capital market, its impact is small at the beginning. But from the development trend, it showed an increasing trend. The volatility of the gold-oil ratio can be regarded as a bellwether of the medium - and long-term market risk degree of China's capital market.

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