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# Dynamic interacting relationships among international oil prices, macroeconomic variables and precious metal prices

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**Abstract:** From the perspective of long-term and short-term, the methods of TY causality test, generalized impulse response function, variance decomposition were used to investigate the impacts of international oil prices and macroeconomic variables on Chinese gold, silver and platinum prices, but also the feedback effects of Chinese precious metal prices under this impact. The results show that international oil prices play an important role in precious metal price variation both in long-term and short-term, and exchange rate only has an effect in short-term, while interest rate is ineffective in predicting precious metal prices. In addition, precious metal prices have some feedback effects on international oil prices and interest rate in short-term.

**Key words:** international oil price; precious metal price; TY causality test; generalized impulse response function; variance decomposition

## 1 Introduction

Commodity market always attracts attention of researchers. Because commodity is closely related to industrial production and it could be efficient sign for inflation. Besides, commodity plays an indispensable role in hedging and multi investment portfolios. Taking gold, silver and platinum as an example, the commodity feature and financial feature of those precious metals are widely concerned. China is the second net import country of petroleum and the great demand helps to increase oil prices and it could lead to inflation and fluctuation of exchange rate domestically. In this situation, investors turn to precious metals to resist inflation and exchange rate risk. Precious metals, to some extent, are regarded as reserve currency which could stimulate production and consumption of precious metals. It should have some effects on exchange rate and interest rate. Intensive need of petroleum and precious metal, to some extent, could drive price linkage among those commodities.

Recently, researchers have paid attention to relationship between international oil prices and main macroeconomic variables with prices of precious metals. These literatures could be concluded to four aspects. 1) The relationship between oil prices and precious metal prices. SARI et al [1] found that oil and silver were shortly related in developed countries and they also displayed the inner relationship mechanism of oil and precious metals [2]. ZHANG and WEI [3] advocated that in the sample period, the relation coefficient of prices of gold and oil was 0.9295 and they had long-term equilibrium relationship. 2) The relationship between main macroeconomic variables and precious metal prices. TULLY and LUCEY [4] found that US dollar was the most important factor and, at most situation, was even the only variable leading to exchange rate fluctuation. By establishing the error correction model, SJAASTAD [5] got the conclusion that floating exchange rate system was main cause for unsteady international gold price. HAMMOUDEH et al [6] found that the introduction of exchange rate increased direct and indirect impacts on commodity futures in all models.

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3) The relationship between oil prices and macroeconomic variables. The research of AMANO and NORDEN [7] presented that in the relationship between oil price and real exchange rate, oil price took the dominant position. And interest rate was significant variable linking to oil market, exchange rate and currency policy. Oil price could offer some information to the market participants. SJAASTAD and SCACCIAVILLANI [8] indicated that increasing oil price resulted in depreciation of US dollar within net oil exporting countries. TANG and LUO [9] discovered that shocks of oil price lead to appreciation of real exchange rate in China. 4) The relationship among precious metal prices. CINER [10] discussed the absence of the long-term relationship between gold and silver in Tokyo Commodity Exchange in 1990's. LUCEY and TULLY [11] considered that the steady relationship between gold and silver could be sustained and even the relationship was weak at this moment. By GARCH models and EGARCH models, MORALES [12] studied volatility spillover effect among gold, silver, platinum and palladium, and there was evidence that the relationship was bidirectional. But there was little evidence that other precious metal markets could influence gold market.

Besides, some researchers are trying to study the relationship between oil prices and macroeconomic variables with precious metal prices in an integrated frame. SARI et al [2] found that there was weak long-term equilibrium relationship among precious metal prices, oil prices and exchange rate. By VAR model, HUANG et al [13] analyzed impacts of US dollar and oil price on Chinese copper, gold and silver. The result showed that the relationship between US dollar, gold and silver determined prices of Chinese gold and silver. Based on weekly data, LI and FU [14] established VAR-DCC-MVGARCH model to estimate the dynamic relationship among oil, gold, interest rate, exchange rate and stock market in China.

According to the above description, researchers around the world have not received an agreement about relationship among oil prices, macroeconomic variables and precious metal prices. At this moment the existing literatures are lack of synthesis and are aimed at developed countries. With economical and financial development in emerging countries, those emerging capital markets could present more global shocks. Besides, economy situations are different between developed and developing countries, which could lead to completely different conclusions. As a result, constructing a new frame directing to emerging market, such as China, to discuss dynamic relationship among petroleum, macroeconomic variables and precious metals seems very necessary. Based on TY causality test, generalized impulse response function and variance decomposition, bidirectional dynamic characteristics of international oil prices, interest rate, exchange rate and Chinese precious metal prices were studied. Main innovations include three aspects. 1) Information loss could be avoided by without considering cointegration test of TY causality test and rankings of variables in VAR model of generalized impulse response function, so interactive relationship among variables could be precisely described. 2) From short-term and long-term perspective, the dynamic relationship among global oil prices, interest rate, exchange rate and Chinese precious metal prices is reflected in time and in section-cross series. 3) Some new issues are added in this work, such as the relationship between oil and interest rate, the relationship between interest rate and precious metals.

## 2 Methodology

### 2.1 TY causality test

In order to determine the long-term relationship among variables, this work is based on TY causality test. Unlike other common causality tests, the main advantage of the TY procedure is that in this procedure there is no need to test for cointegration. Hence, a likely pretest bias is avoided. Furthermore, the TY procedure allows us to run a VAR in levels, regardless of whether the series have the same order of integration or not. Therefore, there is no information loss due to differencing and the procedure is more flexible in considering arbitrary levels of integration.

According to TODA and YAMAMOTO [15], the following VAR representation for $Y_t$ is considered:

$$Y_t = c + \Phi_1 Y_{t-1} + \cdots + \Phi_k Y_{t-k} + u_t \tag{1}$$

where $Y_t = (y_{1t}, y_{2t}, \cdots)$; $\Phi$ are coefficients to be estimated; $c$ is a vector of constants; $t$ is linear time trend; $k$ is the optimal lag length; and $u_t$ is a vector well-behaved disturbances. In this model, the null hypothesis is that there is no causality, the null hypothesis can be expressed as elements in coefficient matrixes that are all equal to zero. The TY procedure starts with determining the maximum integration order ($d$) for the series in concern. Then, the optimum lag length ($k$) is determined via some information criteria. If the augmented vector autoregression VAR($k$+$d$) satisfies the common assumptions, a Wald test on the joint significance of the first $k$ lags of each variable constitutes a long-run Granger causality test. The Wald test statistic follows an asymptotic Chi-square distribution with $k$ degrees of freedom.

Two problems need to be solved to process TY causality test: the maximum integration order ($d$) for the series and the optimum lag length ($k$) for VAR model. We employ ADF unit root test to assess the order of integration, and use LR statistic, Akaike Information Criterion or Schwartz Criterion to determine the lag order for VAR model.

### 2.2 Generalized impulse response function

In order to study the short-term dynamic impact reaction among international oil prices, interest rate, exchange rate and precious metal prices, this research is also based on GIRF, which is presented by KOOP et al [16]. The basic thought of GIRF is expressed as

$$\mathrm{GIR}(n,\delta_j,\bar{\omega}_{t-1})=E(x_{t+n}\mid\varepsilon_{jt}=\delta_j,\bar{\omega}_{t-1})-E(x_{t+n}\mid\bar{\omega}_{t-1}) \tag{2}$$

where $\delta_j$ represents the shocks from the $j$th variable, and $\bar{\omega}_{t-1}$ represents the set of all available information when shocks occur. Further, assuming that $\varepsilon_t$ has a multivariate normal distribution, it is now easily seen that

$$E(\varepsilon_t\mid\varepsilon_{jt}=\delta_j)=(\sigma_{1j},\sigma_{2j},\ldots,\sigma_{kj})'\sigma_{jj}^{-1}\delta_j=\sum e_j\sigma_{jj}^{-1}\delta_j \tag{3}$$

where $e_j$ is an $m\times1$ selection vector with unity as its $j$th element and zero elsewhere. By setting $\delta_j=\sqrt{\sigma_{jj}}$, we obtain the scaled generalized impulse response function by

$$\psi(n)=\sigma_{jj}^{-1/2}A_n\sum e_j,\ \ n=0,1,2\cdots \tag{4}$$

$$A_n=\sum_{k=1}^{n}A_{n-k}\Phi_k\ ,\ \ A_0=I_m \tag{5}$$

A conclusion can be drawn from Eq. (4) that unlike orthogonalization impact reaction, the result from GIRF does not rely on the order of variables in the VAR system.

### 2.3 Variance decomposition theory

According to the forms of VAR, SIMS [17] proposed variance decomposition method to quantitatively measure the relationship between the variables:

$$y_{it}=\sum_{j=1}^{k}(c_{ij}^{(0)}\varepsilon_{jt}+c_{ij}^{(1)}\varepsilon_{jt-1}+c_{ij}^{(2)}\varepsilon_{jt-2}+\cdots) \tag{6}$$

The content inside each parenthesis is overall influence of the $j$th disturbing term $\varepsilon_j$ on $y_t$ from the infinite past to the current time point. The variance is obtained. It is assumed that sequence $\varepsilon_t$ has nothing to do with it:

$$E\left[(c_{ij}^{(0)}\varepsilon_{jt}+c_{ij}^{(1)}\varepsilon_{jt-1}+c_{ij}^{(2)}\varepsilon_{jt-2}+\cdots)^2\right]=\sum_{q=0}^{\infty}(c_{ij}^{(q)})^2\delta_{jj} \tag{7}$$

This is the result of the influence of the $j$th disturbing term on the $i$th variable from the infinite past to the current time point, which is assessed by the variance. Here, it is assumed that covariance matrix of vector of disturbing term is diagonal matrix, so the variance of $y_i$ is the $k$ diagonal matrix of the above variance:

$$\mathrm{var}(y_{it})=\sum_{j=1}^{k}\left\{\sum_{q=0}^{\infty}(c_{ij}^{q})^2\delta_{jj}\right\} \tag{8}$$

The variance of $y_i$ can be dissembled into $k$ irrelevant influences. Therefore, in order to measure the degree of influence of each disturbing term on variance of $y_i$, the following measurement is defined:

$$\mathrm{RVC}_{j\to i}(\infty)=\frac{\sum_{q=0}^{\infty}(c_{ij}^{(q)})^2\delta_{jj}}{\mathrm{VAR}(y_{it})}=\frac{\sum_{q=0}^{\infty}(c_{ij}^{(q)})^2\delta_{jj}}{\sum_{j=1}^{k}\left\{\sum_{q=0}^{\infty}(c_{ij}^{(q)})^2\delta_{jj}\right\}} \tag{9}$$

RVC is the relative variance contribution, that is, to observe the influence of the $j$th variable on the $i$th variable according to the relative degree of contribution of the $j$th variable to the variable of $y_i$ based on the variable of the impact. Actually, it is impossible to evaluate by means of the sum of $c_{ij}^{(q)}$ terms till $q=\infty$. If the model satisfies the condition of stable term, $c_{ij}^{(q)}$ assumes attenuation in geometrical progression with the increase of $q$. Therefore, it is feasible to obtain the limited $q$ terms.

## 3 Empirical analysis

### 3.1 Data selection and processing

This paper selects daily time series data for spot prices of Brent crude oil, spot prices of domestic gold, silver and platinum prices, Pledge-style Repo bond interest rate, exchange rate of RMB against USD, which are recorded as brent, gold, silver, platinum, bond and er, respectively. Since silver trading started on October 30, 2006, the sample data in this paper range from October 30, 2006 to July 5, 2013, a total of 1616 data. All data come from Wind database. During the period, exchange rate experiences a download trend which means that RMB is appreciating continually. In order to eliminate the heteroskedasticity in the time series, all data are used for the natural logarithm, which are recorded as lbrent, lgold, lsilver, lplatinum, lbond, ler, respectively. Table 1 lists descriptive statistics of raw data.

As shown in Table 1, it can be seen from the mean value that platinum is the most expensive, which reflects its title of “king of precious metals”, and gold is cheaper

**Table 1** Descriptive statistics analysis of raw data

| Item | Mean | Median | Variation coefficient | Skewness | Kurtosis | Jarque−Bera | *P*-value |
|---|---|---|---|---|---|---|---|
| Brent | 89.46 | 90.84 | 0.27 | −0.18 | 2.04 | 70.16 | 0 |
| Gold | 253.44 | 248.82 | 0.27 | 0.14 | 1.60 | 136.71 | 0 |
| Silver | 4.83 | 4.11 | 0.35 | 0.68 | 2.40 | 148.12 | 0 |
| Platinum | 337.46 | 334.5 | 0.17 | 0.23 | 4.03 | 86.4 | 0 |
| Bond | 2.83 | 2.79 | 0.47 | 1.40 | 6.93 | 1570.13 | 0 |
| Er | 6.81 | 6.83 | 0.07 | 0.76 | 2.69 | 161.86 | 0 |

than platinum, while silver is the cheapest. The variation coefficient demonstrated that the interest rate volatility is the highest, for the reason that interest rate is often adopted as a tool to fight against inflation. However, the exchange rate volatility is the lowest, which is related to foreign exchange control in our country. Moreover, the volatility of silver is rather high. From the point of skewness, all variables are skew to the right except that international oil prices are skew to the left. From the view of kurtosis, only platinum prices and interest rate render the characteristics of peak and fat tail. Finally, as can be seen from Jarque−Bera statistics, all the time series are not normal distribution.

### 3.2 Result of TY causality test

We firstly employ ADF test to determine the order of integration for all six variables. From Table 2, we know that, except the lbond sequence, all the logarithmic sequences are not stable.

**Table 2** ADF unit root test results of logarithmic sequences

| Variable | ADF statistic | *P*-value |
|---|---|---|
| lbrent | −1.83 | 0.37 |
| lgold | −0.81 | 0.96 |
| lsilver | −0.72 | 0.97 |
| lplatinum | −1.75 | 0.73 |
| lbond | −5.10 | 0.00 |
| ler | −1.73 | 0.74 |

While from Table 3, all variables of first difference sequences are significant at 1% level and have passed the stationary test, illustrating that the maximum order of integration is 1.

Hence, we next proceed to the determination of optimal lag length($k$) for the VAR in levels, among the five criteria employed, four criteria as FPE, AIC, SC and HQ are pointed out, and the optimal lag order number is 2. Then, the VAR($k$+$d$) in levels is run. The lag augmented VAR(3) system is adopted as

$$V_t = \alpha_v + \beta_1 V_{t-1} + \beta_2 V_{t-2} + \beta_3 V_{t-3} + \varepsilon_{vt} \tag{10}$$

where $V_t$=(lbrent$_t$, lgold$_t$, lsilver$_t$, lplatinum$_t$, lbond$_t$, ler$_t$),

**Table 3** ADF unit root test results of first difference sequences

| Variable | ADF statistic | *P*-value |
|---|---|---|
| Δlbrent | −40.68 | 0 |
| Δlgold | −41.23 | 0 |
| Δlsilver | −26.28 | 0 |
| Δlplatinum | −26.69 | 0 |
| Δbond | −15.92 | 0 |
| Δler | −38.85 | 0 |

$\alpha_v$ is a (6×1) vector of constants, $\beta_1$, $\beta_2$ and $\beta_3$ are (6×6) coefficient matrixs, and the $\varepsilon_{vt}$ (6×1) vector represents the residual term. VAR(3) model meets the stationary conditions, which means that all roots are within the unit circle. Then the results of long-term TY causality test will be realized by Wald statistic, which take the first two coefficients of each equation to construct Wald statistic. The significance of statistic means that the column variable granger causes the row variable in the long term. The results are shown in Table 4.

Table 4 shows that international oil prices significantly influence gold, silver, platinum spot price of our country at the 1% level, illustrating that international oil prices have significant predictive power to precious metal prices in China. Its economic significance is that the import and consumption volume of oil is very large as an important strategic material in our country's industrial development. To some extent, Chinese demand increases the international oil price and prompts the formation of imported inflation. To fight against inflation, capital is turned to precious metals investment for preservation which has given rise to precious metal

**Table 4** Results of long-term TY causality test

| Variable | lbrent | lgold | lsilver | lplatinum | lbond | ler |
|---|---|---|---|---|---|---|
| lbrent | − | 2.18 | 2.68 | 0.56 | 2.68 | 0.35 |
| lgold | 46.74* | − | 2.24 | 16.37* | 0.74 | 0.30 |
| lsilver | 45.46* | 110.47* | − | 0.61 | 0.15 | 1.48 |
| lplatinum | 92.75* | 0.65 | 3.29 | − | 0.06 | 0.75 |
| lbond | 0.11 | 0.48 | 1.92 | 0.88 | − | 0.04 |
| ler | 45.25* | 0.74 | 1.29 | 3.25 | 0.90 | − |

* represents significance of 1% level

prices such as gold. It is proved that commodity price linkage is growing gradually in today's economic globalization.

On the other hand, our precious metal prices cannot lead international oil prices, which means that precious metal prices of China have no feedback effect on international oil prices. The result is no surprise since the price of oil is global, which is affected by fundamentals of global supply and demand. Therefore, although Chinese oil import and consumption volume is quite large every year, it is not enough to predict the international oil prices.

As for no interaction among interest rate, exchange rate and precious metal prices in China, it is the surprising result. This means that China's interest rate and exchange rate on the forecast domestic precious metal prices is invalid, which is opposite with the study result of the BAFFES and GARDNER [18]. In developed countries, in generally, when interest rate increases, precious metal prices also follow up. On one hand, this is partly because Chinese precious metals trading starts late and the overall trading is not active, and because of the law of one price and arbitrage activities, the Chinese domestic precious metal prices are likely to follow the global precious metal markets rather than affected by domestic macroeconomic variables. On the other hand, there are still regulations for Chinese interest rate and exchange rate, and cause long-term separation between bond market and commodity market, exchange rate market and commodity market, resulting in the invalidity of interest rate and exchange rate on predicting commodity prices.

Besides, from Table 4 we can also know that international oil price has a unidirectional causality relationship to the exchange rate of RMB against USD because the oil is priced in US dollar so that oil price is closely linked to the value of the dollar or dollar currency rate. As for the long-term interactive relationship between the precious metal prices, the empirical results support that the gold prices lead silver prices. This is because gold as an investment and monetary asset has more advantages than silver as its high liquidity while the liquidity of silver is relatively low, and the use of industrial metals also has limitations. But, contrary to expectations, platinum has a unidirectional leading relationship to gold; possible explanation is, as "the king of precious metals", platinum price is generally higher than gold price and the price ratio remains 1.2:1. In addition, the gold is mainly used to produce jewelry while platinum is more likely for industrial, which results in that platinum is more sensitive than gold to reflect the industry development.

### 3.3 Results of generalized impulse response function

Based on the generalized impulse response function, this paper respectively investigates the dynamic impulse response between international oil prices, macroeconomic variables and precious metal prices.

According to AIC and SC criterions this paper determines the order of the model. After several comparisons of actual estimates, the lag order of these variables is 2, and the model is set to be VAR(2). The results obtained by applying the method of GIRF to respectively investigate the impulse response function between international oil prices, interest rate, exchange rate and precious metal prices. Considering the short time span, the impulse response period is set to be 10.

Firstly, Fig. 1 shows that the impulse response curves of precious metal prices to international oil prices are above the horizon. Figure 2 shows that the impulse response curves of precious metal prices to interest rate are close to the horizon. Figure 3 shows that the impulse response curves of precious metal prices to exchange rate are beneath the horizon. It shows that in short-term the international oil prices rising has a significant effect on precious metal prices increasing. While exchange rate has a negative effect on precious metal prices, which means that in short-term RMB exchange rate has the ability to forecast gold prices, and domestic gold can be used to build a portfolio in order to prevent inflation and devaluation of RMB. Besides, interest rate has few effects on precious metal prices.

Secondly, Fig. 4 shows that the impulse response curves of international oil prices to precious metal prices are above the horizon. Figure 5 shows that the impulse response curve of interest rate to silver prices is above the horizon, and the impulse response curves of interest rate to gold and platinum prices are beneath the horizon. Figure 6 shows that the impulse response curves of exchange rate to precious metal prices are close to the

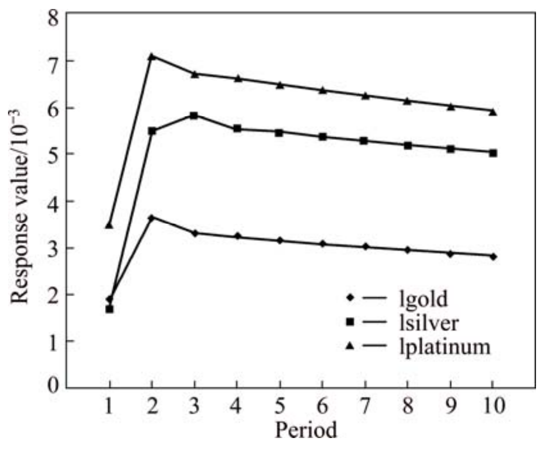


**Fig. 1** Response of precious metal prices to international oil prices

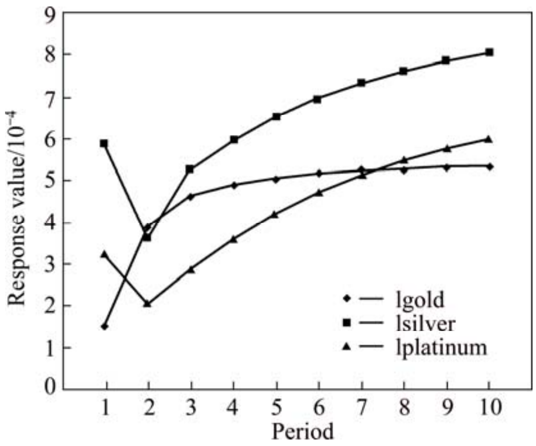


**Fig. 2** Response of precious metal prices to interest rate

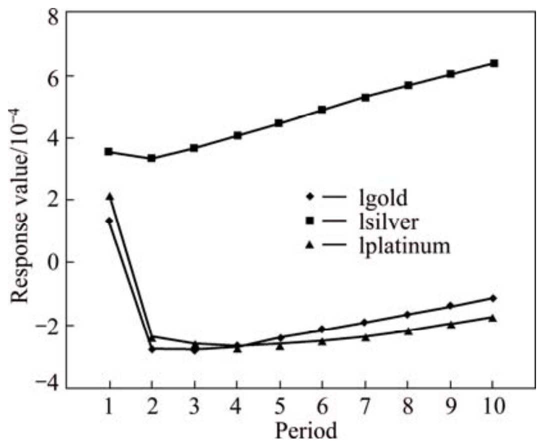


**Fig. 5** Response of interest rate to precious metal prices

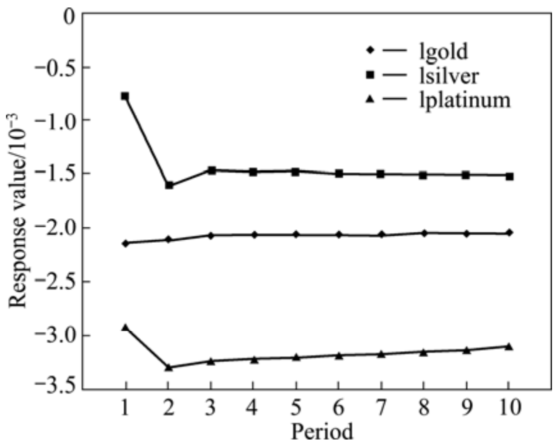


**Fig. 3** Response of precious metal prices to exchange rate

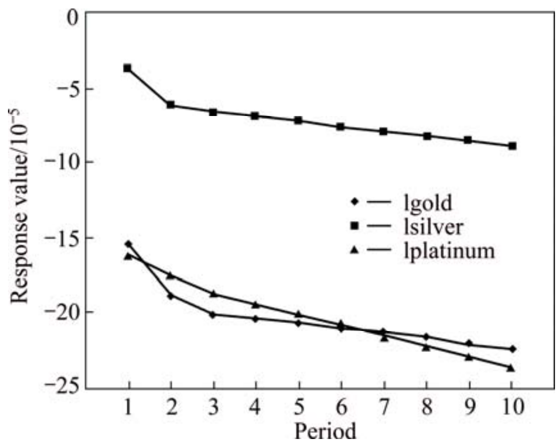


**Fig. 6** Response of exchange rate to precious metal prices

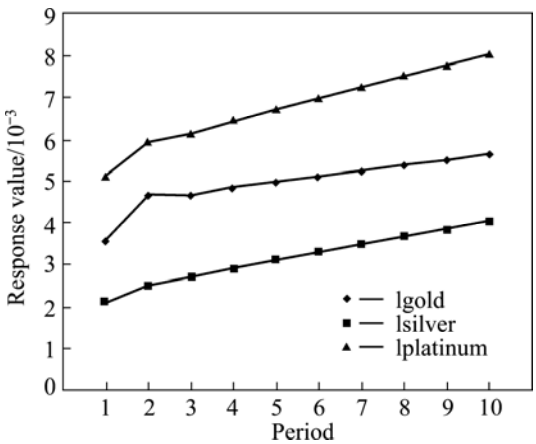


**Fig. 4** Response of international oil prices to precious metal prices

horizon. It shows that in short-term precious metal prices have a feedback effect on international oil prices and interest rate, while precious metal prices have a positive effect on international oil prices. It may be due to the further integration between the international precious metal markets and the domestic precious metal markets, which causes the short-term relationship between oil prices and precious metal prices. But this relationship is temporary, and will disappear soon. This is a positive phenomenon in worldwide, and the linkage between the international and domestic commodity prices is increasing, which will contribute to global trading and investment liberalization. Besides, the phenomenon which precious metal prices have a negative effect on interest rate does not exist in developed countries. In developed countries, if interest rate increases, the precious metal prices will also increase. But the impact of precious metal prices on exchange rate can be ignored.

### 3.4 Result of variance decomposition

Variance decomposition method will be used to examine level of mutual influence among international oil prices, interest rate, exchange rate and precious metal prices in the following part. The results are respectively shown in Tables 5, 6 and 7, respectively.

From the results of variance decomposition, it can be found that the forecast error variance of each precious metal can be significantly explained by international

**Table 5** Variance decomposition results of gold and other variables

| Item | Effect of other variables on lgold/% | Effect of lgold on other variables/% |
|---|---|---|
| lbrent | 6.473 | 0.794 |
| lsilver | 0.054 | 36.556 |
| lplatinum | 0.608 | 36.070 |
| lbond | 0.081 | 0.115 |
| ler | 0.002 | 4.020 |

**Table 6** Variance decomposition results of silver and other variables

| Item | Effect of other variables on lsilver/% | Effect of lsilver on other variables/% |
|---|---|---|
| lbrent | 7.081 | 0.136 |
| lgold | 36.556 | 0.054 |
| lplatinum | 0.011 | 0.808 |
| lbond | 0.006 | 0.406 |
| ler | 0.046 | 0.027 |

**Table 7** Variance decomposition results of platinum and other variables

| Item | Effect of other variables on lplatinum/% | Effect of lplatinum on other variables/% |
|---|---|---|
| lbrent | 15.134 | 0.567 |
| lgold | 36.070 | 0.608 |
| lsilver | 0.808 | 0.011 |
| lbond | 0.011 | 0.131 |
| ler | 0.023 | 0.768 |

oil prices, which is up to over 6% and the impact of international oil prices on forecast error variance of platinum even reaches more than 15%, while the variance of each precious metal explained by interest rate and exchange rate is quite small, which is below 0.1%. This analysis results further validate that domestic precious metal prices are mainly affected by international factors such as international oil prices. Domestic macroeconomic variables have failed to predict the price movements of precious metals.

In contrast, each precious metal does not significantly explain the variance of international oil prices, interest rate and exchange rate, but in terms of the interaction between the precious metals, the impact of gold on forecast error variances of silver and platinum is great, which are respectively 36.5% and 36%. This is because gold has larger trading volume, higher liquidity and wider recognition in China, which results in a significant impact on silver, platinum and other precious metal prices.

## 4 Conclusions

1) Both in long and short term, international oil price is an important factor for precious metal prices volatility, exchange rate will have a negative impact on precious metal prices in the short term, while interest rate fails to predict the precious metal prices.

2) Precious metal prices provide some feedback effects on oil price and interest rate in short term, which precious metal prices will have a positive effect on international oil prices and impose a negative impact on interest rate.

3) International oil prices play an important role in explaining the forecast error variance of precious metal prices volatility. However, the variance of each precious metal explained by interest rate and exchange rate is quite small. This result reminds us that on one hand, great attention should be paid to prevent imported inflation caused by rising international oil prices; on the other hand, the function of domestic macroeconomic variables' predicting precious metal prices has not been fully realized.

4) Overall, in terms of the interaction between precious metals, gold plays a vital role in explaining the forecast error variance of other precious metals. It shows that in China, gold as an investment and monetary asset bears more advantages than other precious metals and fits to be a major haven for funds.

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# 国际油价、宏观经济变量与贵金属价格的动态交互影响

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**摘　要**：基于长期与短期两个视角，采用 TY 因果检验、广义脉冲响应函数及方差分解等方法，系统考察国际油价及宏观经济变量对我国黄金、白银和铂金 3 种贵金属价格的冲击影响，以及在此冲击作用下我国贵金属价格的反馈作用。结果表明：国际油价在长、短期内都是贵金属价格变动的重要原因，而汇率则只在短期内对贵金属价格产生影响，利率在预测贵金属价格上则处于失效状态。此外，在短期内，贵金属价格对国际油价与利率也存在一定反馈作用。

**关键词**：国际油价；贵金属价格；TY 因果检验；广义脉冲响应函数；方差分解

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