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Research of the Influence of Macro-Economic Factors on the Price of Gold

Li Lili*, Diao Chengmei

Economic College, Qingdao University, Qingdao, 266071, China

Abstract

This paper shows the dynamics of gold prices in the Gold Exchange in NEW YORK using a dataset that includes global macroeconomic indicators, financial market indices, quantities and prices of energy products. We extract common factors from the panel data series and estimate a Factor-Augmented Vector Auto-regression for gold prices. It shows that a factor correlated to purely financial developments contributes to the model performance, in addition to factors related to gold reserves and energy prices. This paper has two main contributions. First, all factors influencing the gold market have been classified into three groups, that is, gold reserve and prices of energy products , financial market indices , global macro-economic indicators . We can see that the effect of financial market indices and macroeconomic indicators to gold price is negative, the effect of gold reserve and prices of energy product to gold price is positive. Second, we apply the FAVAR model to analysis factors influencing gold price and the trend of gold price.

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Keywords: Price of Gold; FAVAR model; Macro-Economic Factors

1. Main text

This paper mainly discusses the influence of macro-economic factors on the price of gold. All factors influencing the gold market have been classified into three groups: gold reserve and prices of energy products, financial market indices and global macro-economic indicators. FAVAR model is applied to analyze factors which can influence gold price. In the whole, the relationship between gold reserve and prices of energy product and gold spot price is positive, the effect of financial market indices and global macroeconomic indicators are negative.

* Corresponding author. Tel.:+0-086-532-85953417; fax: +0-086-532-85953390.
E-mail address: lili_lee2003@126.com.

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Nomenclature	
A	FAVAR model
B	Principal Component Analysis

1.1. Introduction

The outbreak of the global financial crisis has made many countries' markets fall down sharply. The securities and future market's risk increase suddenly; at the same time, the gold market has attracted a large number of investors in the gold market because of its function of hedging. However, the gold market has risk too. The price of gold will fluctuate as some relative factors do. The in-depth's study will help us better understand the rule, improving the gold investment rate of return. Factors influencing the gold market include inflation rate, interest rate, exchange rate, stock price index and so on. Gold price formation is a very complicated economic process. Many factors have effects on the gold price. And the price of gold has been a problem that theorists have been exploring all the time.

1.2. Literature review

Domestic previous research methods for this problem are mainly grey prediction model and Markov chain combination method (Qin Sheng and Chen Yang(2010)), BP neural network model (Gu Mengjun and Zhang Zhihe（2007)) and Grey Markoff model(Qin Sheng and Chen Yang(2010)) and ARFIMA model(Lin Yu (2010)) etc. Also, long-term regression model was applied to analysis the factors influencing the gold price which can give good results about the impact on the gold price mechanism (Bai Yichi); and Qian Bingbing(2007）has selected a fuzzy time series model to determine the initial parameters of fuzzy system, while the use of a Type-2 and Type-1 fuzzy system. Fuzzy system is a good choice for training and prediction. To some extent, these models are accurate predictors of the gold price trend.

For the international part, there are a plethora of methodological approaches. As with all methodologies, each is confronted with its own pros and cons. The methods range from qualitative methods (the most commonly used methods are judge mental forecasting, intensity of-use concept and the Delphi method); cost and reserve-based methods; trend extrapolation and time-series methods (e.g. Gocht et al., 1988); causal or behavioral models; to the use of futures markets for price forecasting (e.g. Roche, 1995). In terms of trend extrapolation and time-series methods, they attempt to forecast by extrapolating from past trends of prices. In other words, they empirically evaluate trends. Time-series methods are superior to trend extrapolation in their rigor and sophistication. However, ARIMA model provides marginally better forecast results than lagged forward price model (Gillian Dooley, Helena Lanihan 2005).Recursive and rolling neural network models are applied to forecast one-step-ahead sign variations in gold price.(Antonino Parisi, Franco Parisi, David Diaz 2008); A new method considers price jumps or dips in the models which does not separate mean reverting rate with jump time to forecast the price. This type of model contains slightly modified assumptions from the classical models.(Shahriar shafiee, Erkan Topal 2010). The forecasting for platinum, silver and gold prices using trader positions is investigated in a VAR framework. Granger causality tests are conducted to determine whether a relation between trader positions and market prices exists.(Takvor H.Mutafoglu a, EkinTokat b,n, HakkiA.Tokat c 2012).

There are a large number of papers that emphasize on theoretical analysis instead of model construction. These papers analyze many factors influencing the gold price trend and the mechanism according to economic phenomenon.However, this paper introduced a new method. This is Factor-augmented VAR model, which is based on a large amount of economic variables. And we can get good results for forecasting the gold market trend.

1.3. The structure of FAVAR model

The model presented here is based on the assumption that the futures price for one maturity is driven both by the prices of the other maturities, and by macroeconomic shocks. The macroeconomic determinants are proxied by unobservable factors that summarize the common information in a large number of time series. The joint dynamics of the observable an unobservable variables in modelled in the FAVAR model of Bernanke et al. (2008). The general form of the FAVAR can be written as

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \mu + \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t \tag{1}$$

$\Phi(L)$ is a matrix of lag polynomials, and v_t is a vector of normally-distributed shocks. Y_t is a vector $m \times 1$ of observed variables.

The unobservable factors are collected in the $k \times 1$ vector F_t. Eq (1) explains that the dynamics of the factors is affected by its own lags, by the vector of observables, and by the shocks. The model 1 has a variance–covariance matrix Σ. Eq (1) can not be estimated without knowledge of F_t. For that purpose, a large number p of series can be used to extract 'common' factors. The 'information series' are collected in the vector X_t with dimension $p \times 1$. The dynamic factor model of Stock and Watson(2002) can then be used to obtain F_t. This framework assumes that the information time-series X_t are related to the factors F_t and the observed variables Y through the observation equation

$$X_t = \Lambda^f Y_t + \Lambda^y Y_t + \varepsilon_t \tag{2}$$

Λ^f is a $p \times k$ matrix of factor loadings. The measurement equation formalizes the idea that both the oil futures returns and the factors drive the dynamics of the panel dataset. In other words, the factors can be measured with noise from the panel dataset. In this paper, we apply the two-step estimation procedure. Thus, we extract unobservable factors by using the asymptotic principal component method. Extracting the common factors from the panel dataset consists in recovering the space of X_t spanned by F. Denote by V the eigenvectors corresponding to the k largest eigenvalue of the variance–covariance matrix XX'/k. The estimated factors are $\hat{F}_t = \sqrt{T}V$, where T is the time-series' length, and the factor loadings are $\hat{\Lambda}^f = \sqrt{T}X'V$.

1.4. Empirical analysis

1.4.1. The dataset

Considering the availability of data, we use yearly standardized data from 1987 until 2005 for a total of 11 observations for each series. Then we make a forecast from 2006 to 2011 using the FAVAR model. The vector Y consists of the spot price for gold traded in the New York Gold Exchange, and the panel dataset used for the extraction of the factors comprises 11 series that are meant to capture the macroeconomic, financial and geographic forces that move gold prices. Though the dataset is not large enough, it doesn't affect the analysis. Here we extract three main factors to analyze the factors which influence the gold price.

1.4.2. The analysis method

In the first step of the estimation, we extract three common factors from the panel dataset using principal components. The first three factors account for around 90% of the variability contained in the dataset. That is global macroeconomic indicators, financial market indices, gold reserve and prices of energy products. They exhibit a high degree of persistence. The estimated autocorrelation coefficients are quite different across factors.

We break down the contribution to the loadings of each factor by three groups of series, divided into gold reserve and energy prices (F_1), purely financial data (F_2) and macro data (F_3). The contributions to the factors differ largely across series. Energy prices provide the largest contribution to the first factor. Financial data instead account for the largest weights in the second factor. Finally, macro and financial series determine the largest fraction of the third factor. However the world's gold reserves have a negative influence on the gold spot price in the first factor, and for other two factors, it also has a strong influence.

1.4.3. The ADF test

The extended Dickey-Fuller test (ADF) separately for growth rate of each target are as follows, energy prices (F_1), purely financial data (F_2) and macro data (F_3), unit root test is used for all factors. Part of variables' first order difference results can be seen on Table 1.

Table 1 ADF Test

Variable	ADF Test Statistic	α (Sig. level)	Critical Value
F_1	-1.69033		
F_2	-1.67965	1%	-3.7497
F_3	-2.40024	5%	-2.9969
Y	1.840647	10%	-2.6381

Through Table 1, F_1, F_2, F_3, Y statistics of absolute value are less than the critical value of the absolute value of 10%. That indicate that these variables in the ADF test method have unit root, i.e. they are not stationary time series, satisfying at least integrated of 1.

1.4.4. Causality test

As F_1, F_2, F_3, Y all go through the unit root test, so we made further test to see whether they have a long-term co-integration relationship. Here we use Grainger causality test to see their relationship. Table 3 shows: F_1 and F_2, F_1 and F_3, F_2 and F_3, there exists weak causal relationship, that is to say energy prices, purely financial data and macro data doesn't have obvious causality, but F_3 and Y have two-way causality, from F_2 to Y one-way causality, F_1 and Y have two-way causality.

Table2 Granger causality tests

Null Hypothesis	Obs	F-Statistic	Prob
Y does not Granger Cause F_1	17	0.73746	0.4922
F_1 does not Granger Cause Y		3.28816	0.0606
F_3 does not Granger Cause F_2	17	0.63109	0.5434
F_2 does not Granger Cause F_3		2.65236	0.0978
Y does not Granger Cause F_2	17	0.11586	0.8913
F_2 does not Granger Cause Y		2.63743	0.099

Y does not Granger Cause F_3	17	2.64596	0.0983
F_3 does not Granger Cause Y		2.07771	0.1542

So it is concluded: energy prices, purely financial data and macro data all have causal relationship with gold price, that prove that the factors which have been thought to influence gold price have a scientific foundation.

1.4.5. VAR model construction

Firstly, we get three principal components from all the variables through asymptotic principal components. Those are $\hat{C}_1, \hat{C}_2, \hat{C}_3$. Secondly, we get three principal components from X_1 to X_{10}, those are $\hat{F}_1, \hat{F}_2, \hat{F}_3$. Then we do regression analysis based on the equation $\hat{C}_t = b_{fs}\hat{F}_t^s + b_y Y_t + \varepsilon_t$. We get the regression coefficients $\hat{b}_y$. Then we get the unobservable variables: $\hat{F}_t = \hat{C}_t - \hat{b}_y Y_t$, as for this example, $\hat{F}_1 = C_1 - 0.088Y$, $\hat{F}_2 = C_2 + 0.024Y$, $\hat{F}_3 = C_3 + 0.003Y$, then we standardized the data and get F_1, F_2, F_3.

The next step, F_1, F_2, F_3 are combined with Y to build VAR model, which can analyze the factors influencing the gold price trend. Because the AIC discipline value is the smallest, we choose four intervals for Endogenous. The VAR equation is as follows.

$$Y = -12.63F_1(-1) - 0.22F_1(-2) - 3.06F_2(-1) + 0.61F_2(-2) - 0.05F_3(-1) - 0.88F_3(-2) + 13.23Y(-1) + 0.11Y(-2) + 0.23$$

$$F_1 = -21.68F_1(-1) + 0.19F_1(-2) - 5.57F_2(-1) + 0.15F_2(-2) + 0.27F_3(-1) - 0.14F_3(-2) + 21.47Y(-1) + 0.27Y(-2) + 0.19$$

$$F_2 = 43.51F_1(-1) - 1.68F_1(-2) + 11.67F_2(-1) + 1.85F_2(-2) - 1.12F_3(-1) - 3.01F_3(-2) - 40Y(-1) - 0.71Y(-2) + 0.11$$

$$F_3 = 31.09F_1(-1) - 1.16F_1(-2) + 7.97F_2(-1) + 0.85F_2(-2) - 0.21F_3(-1) - 1.26F_3(-2) - 29.11Y(-1) - 0.25Y(-2) - 0.21$$

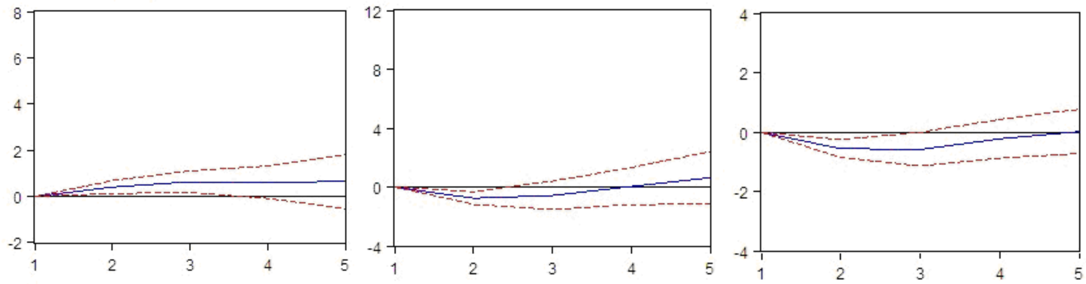
Table3. Prediction value of Y

	2006	2007	2008	2009	2010	2011
prediction value	0.20375	0.69019	1.44151	2.55328	4.12637	6.40769
real value	0.27924	0.86298	0.96714	1.59716	2.51725	2.88037

Table 3 reports the forecast results from 2006 to 2011. Compared the real data with the forecast results, we can make a conclusion that the forecast results of the next year are accurate to some extent, especially the forecast result of Y. We can draw a conclusion that the next one year's forecasting results is accurate by and large. That is to say we can use the FAVAR model to forecast the next one year's gold price and its trend.

1.4.6. Generalized impulse response function

To analysis the effects of the factors on gold price, we made generalized impulse response analysis in the whole. That is, response of F_1 to Y, response of F_2 to Y and response of F_3 to Y.



(a) (b) (c)

Fig. 1 (a) Response of F_1 to Y; (b) Response of F_2 to Y; (c) Response of F_3 to Y

From the impulse response graph, we can see that the relationship between gold reserve and prices of energy product F_1 and gold spot price (Y) is positive, i.e. energy prices such as oil prices have a positive effect on gold price. The graph shows the response time path of gold prices, the response path fluctuate. In the first period, the price of gold will rise as energy prices do, but the influence is declining, it declined to be the weakest in the second period. It has obvious influence in the third period again. Overall, the energy price has a positive effect on gold price. It also confirms that the oil is known as "black gold". Gold and oil both have the function of preserving and increasing the value.

From the impulse response graph, we can see that the effect of F_2 to Y is negative. The response path is negative, and the influence is stable. It indicated that purely financial data have a negative influence on the gold price. For example, if the stock price rises, the gold price will decrease. The fluctuation of the stock market is opposite to the gold market. That also confirms the gold market's hedging function.

From the impulse response graph, we can see that the effect of F_3 to Y is negative, i.e. macroeconomic factors have a negative effect on gold price. The graph shows the response time path of gold prices, the response path fluctuate. In the first period, the price of gold will descend as energy prices rise, it declined to be the strongest in the third period. The path resembles the response path of F_2 to Y .

1.5. Conclusion

In this paper, we apply a new statistical method of FAVAR to study the factors influencing the price of gold and its mechanism, extracting three principal component factors, that is, gold reserve and prices of energy products (F_1), financial market indices(F_2), global macroeconomic indicators(F_3). In the whole, the relationship between gold reserve and prices of energy product (F_1) and gold spot price (Y) is positive, the effect of F_2 to Y is negative. The response path is always negative, and the influence is stable, the effect of F_3 to Y is negative, i.e. macroeconomic factors have a negative effect on gold price. Pulse response of analysis in each part, the price of crude oil and the federal funds rate have a strong force on the spot gold' price, the effect is the most significant. The impulse response function reflects the relation of the factors and the price of gold, so as to make a rough gold price forecast.

The results presented here can be extended in a number of directions. The model can also be used for structural economic analysis. For example, it would be used to identify monetary policy shocks as in Bernanke et al. (2005). The factors could be used to identify the impact of gold demand and supply shocks. In this sense, it would be important to understand what role purely financial market variables can play for the persistence and magnitude of the estimated shocks.

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