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Price linkage between Chinese and international nonferrous metals commodity markets based on VAR-DCC-GARCH models

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Abstract: Using VAR-DCC-GARCH model, the literature on commodity price was extended by exploring the co-movement between Chinese nonferrous metal prices and global nonferrous metal prices represented by the nonferrous metal prices from London Metal Exchange (LME). The results show that LME nonferrous metals prices still have a greater impact on Chinese nonferrous metals prices. However, the impact of Chinese nonferrous metals prices on LME nonferrous metals prices is still weak except for lead price. The co-movement of nonferrous metal prices between LME and China presents hysteretic nature, and it lasts for 7−8 trading days. Furthermore, the co-movement between LME nonferrous metals prices and Chinese nonferrous metals prices has the characteristics of time-varying, and the correlation of lead prices between LME and China is the more stable than all other nonferrous metals prices.

Key words: price linkage; nonferrous metals commodity prices; Chinese metals commodity market; LME; co-movement; VAR model; DCC-GARCH model

1 Introduction

Accompanying the advent of urbanization and heavy industrialization, there is a rapid growth in the demand for metal resources in China. As a result, the international trade volume of metals increases largely in China. According to statistics, China accounts for 40% of the global consumption in copper in 2011. However, 71% of copper in China comes from abroad. The heavy demand for metal resources makes China play a more and more important role in global metal commodity markets, thus Chinese factors have become the major cause which can affect the change in global metal commodity markets [1].

With the economic globalization nowadays, the metal prices are fluctuating more violently than before, in turn, the risk of Chinese market is much larger as well. However, China does not have an enough loud voice in global metal markets. As a result, the metal prices in China fluctuate passively with the global metal prices change. Therefore, we cannot help but ask: Does the changes of metal prices in China can play an important role in the volatility of global metal prices? How do the global metal prices affect Chinese metal commodity market?

An increasing number of studies attempt to explore the relationship between the prices of different commodity markets. CASHIN et al [2] used monthly IMF data on primary commodities to examine the persistence of shocks to world commodity prices, they found that shocks to commodity prices are typically long-lasting and the variability of the persistence of price shocks is quite wide. They also showed that if price shocks are long-lived, then the cost of stabilization schemes will likely exceed any associated smoothing benefits. JOSEPH et al [3] used nonstationary panel methods to document a statistically significant degree of co-movement due to a common factor, which confirmed what CASHIN et al [2] found. In other words, these works suggested that the co-movement of prices is always seen between interrelated commodities, which reflect the degree of interplay between different commodities' prices. Some researchers, however, held

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the opposite view. Studying on the long-run relationship between gold and silver of Tokyo Commodity Exchange, CINER [4] found that the stable long-run relationship between the two precious metals broke down suddenly in the 1990s. He believed that the reason may be that gold and silver have different economic use at that time, in turn, form separate markets. LUCEY and TULLY [5] re-examined the results of CINER [4], they showed that using a longer run of data, for both cash and futures, CINER's finding may be unwarranted. The findings are that while there are periods when the relationship is weak, overall a stable relationship prevails. Additionally, the short-run relationships among different commodities' prices have been studied. LESCAROUX [6] considered monthly data of 51 commodities from 1980 to 2008 to confirm that raw resources exhibit co-movement at high frequencies. SARIA et al [7] examined the co-movements and information transmission among the spot prices of four precious metals (gold, silver, platinum, and palladium), oil price and the US dollar/Euro exchange rate, they found the evidence of a weak long-run equilibrium relationship but strong feedbacks in the short run. Furthermore, some studies explored the influence of international market factors on the change of commodity's prices. MOLLICK et al [8] examined the impact of globalization on commodities terms of trade and the global prices on American commodities' prices. JAIN and GHOSH [9] investigated the cointegration and Granger causality among global oil prices, precious metal (gold, platinum and silver) prices and Indian Rupee-US Dollar exchange rate using daily data spanning from 2nd January 2009 to 30th December 2011. Chinese scholars have done some related studies in recent years as well [10−15], however, there are still few studies focusing on the price linkage between Chinese and international nonferrous metals commodity markets.

According to the above discussion, we find that the majority of the previous studies focus on the relationship or co-movement between different commodities' prices in the same market. However, few of them study the co-movement between the commodities from different markets. Therefore, using VAR model and DCC-GARCH model, the relationship between the global metal prices, which are represented by the metals prices of LME, and Chinese metal prices, which are represented by the prices provided by China Yangtze River Nonferrous Metals Market (YRNMM), was analyzed.

2 Research method and data

2.1 Research method

2.1.1 VAR model

The measurement of return and volatility spillovers is based on vector autoregression (VAR) models, and focuses on the impact from intensity and duration of prices between LME spot market and YRNMM. The VAR(p) model used in this work is given by

$$\boldsymbol{Y}_t = \boldsymbol{A}_0 + \sum_{i=1}^{p} \boldsymbol{A}_i \boldsymbol{Y}_{t-i} + \boldsymbol{\varepsilon}_t \tag{1}$$

$$\boldsymbol{Y}_t = [\ln(l_t/l_{t-1}), \ln(c_t/c_{t-1})]' \tag{2}$$

where l_t is the price of LME nonferrous metals spots in the period of t, c_t is the price of YRNMM nonferrous metals spots in the period of t, $\boldsymbol{A}_n$ is 2×2 parameter matrix of lagged variables, $\boldsymbol{\varepsilon}_t=[\varepsilon_{1,t}, \varepsilon_{2,t}]'$, $E(\varepsilon_t)=0$, $E(\varepsilon_t\varepsilon'_t)=\sigma^2$, $E(\varepsilon_t\varepsilon'_t)=0$, $t\neq s$.

As an efficient causal analysis method, impulse response function can be used to analyze the relationship between variables. Residual in VAR model reflects the impact from external system on system variables, hence, the coefficient matrix in the moving average form, is also impulse response coefficient matrix, that is

$$\boldsymbol{F}_t = C_0 + B_0\boldsymbol{\varepsilon}'_t + B_1\boldsymbol{\varepsilon}'_{t-1} + \cdots + B_n\boldsymbol{\varepsilon}'_{t-n} + \cdots \tag{3}$$

where $\boldsymbol{F}_t=[f_{1,t}, f_{2,t}]'$ and $\boldsymbol{B}_n=[b_{ij,n}]$ are 2×2 coefficient matrixes, $b_{ij,n}$ reflects the impact of $f_{i,t-n}$ on $f_{j,t}$ during the period of $t-n$. Therefore, the accumulative response of $f_{j,t}$ to $f_{j,t}$ can be written as $\sum_{t=0}^{m} b_{ij,t}$.

2.1.2 DCC-GARCH model

DCC-GARCH model suggested by ENGLE [16] has outstanding effect on describing dynamic mechanism of action between financial variables. By calculating dynamic conditional coefficient, it can reflect the influence between variables efficiently. In order to analyze the influence between LME nonferrous metals prices and YRNMM nonferrous metals prices, we adopt DCC-GARCH model to measure the interaction effect of prices between these two markets. Assuming all the nonferrous metals prices follow multivariate normal distribution, we have $r'_{i,t}\big|I_{t-1} \sim N(0, H_t)$. The DCC-GARCH model used in this work is given by

$$\begin{cases} \boldsymbol{H}_t = \boldsymbol{D}_t\boldsymbol{R}_t\boldsymbol{D}_t \\ \boldsymbol{R}_t = \text{diag}(\sqrt{q_{i,j,t}})\boldsymbol{Q}_t\text{diag}(\sqrt{q_{i,j,t}}) \\ \boldsymbol{Q}_t = [q_{i,j,t}] = \boldsymbol{S}(1-\alpha-\beta) + \alpha(\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}'_{t-1}) + \beta\boldsymbol{Q}_{t-1} \\ \rho_{i,j,t} = q_{i,j,t}\Big/\sqrt{q_{i,i,t}q_{j,j,t}} \end{cases} \tag{4}$$

where $\rho_{i,j,t}$ is the dynamic correlation coefficient in DCC-GARCH model, $\boldsymbol{R}_t$ is the dynamic correlation matrix, $\boldsymbol{D}_t = \text{diag}\{\sqrt{h_{i,t}}\}$ is the symmetric matrix of dynamic correlation matrix, $\boldsymbol{Q}_t$ is 2×2 positive definite matrix, $\boldsymbol{S}$ is 2×2 covariance matrix, α and β are the coefficients of DCC-GARCH model.

We can estimate by using two-step method as follows. In the first step, we estimate the coefficient of univariate GARCH model. In the second step, we use the conditional variances standardized residuals obtained