

The Linkage Between International Gold Price and Chinese Stock market

Shaoheng Zhan

School of Business, East China University of Political Science and Law, Shanghai 201060, China

Abstract

Based on the related theory of stock market linkage, this paper uses the Copula model to analyze the correlation between international gold market and the Chinese stock market. The three important nodes of the process of financial and economic internationalization in China are analyzed in stages. According to the results, the correlation between the international gold market and the Chinese stock market is weak in general, when China does not join the WTO, the Chinese stock market and the international gold market are asymptotically independent; with the gradual deepening of China's internationalization process, the tail correlation between the two is gradually increasing.

Keywords

Copula, stock market, linkage analysis, gold, tail correlation.

1. Introduction

As a precious metal, gold has been an important symbol of wealth in human civilization since ancient times. Since the realization of commodity exchange, gold has been one of the most important currencies in the form of metal currency. With the continuous development of human society and the continuous change of currency form, but gold and other precious metals, as the original currency equivalent, still have a very important significance for our society.

Nowadays money mainly takes the form of credit money, which promotes the prosperity and development of the world economy to a certain extent, but it also has a catalytic effect on the financial risks in the world. During the global financial crisis that has erupted repeatedly in recent decades, gold has also become the ideal haven asset for investors. Its stable price level and volatility can avoid the fluctuations of macro risks, real economy, and financial market in case of financial crisis and become a hedging tool. At the same time, facing the risk of inevitable inflation in the era of credit money, gold and other precious metals, as excellent stored value assets, can also meet the needs of investors.

The interdependence between economic development has gradually increased in recent years with the continuous deepening of economic and trade with various regions of the world, and the increase of import and export trade. As an important tool of modern social economy, financial market can circulate funds between capital surplus units and units of funds shortage, on the other hand can reflect the situation and expectations of economic development.

After the main board of the Shanghai Stock Exchange was officially listed in 1990, the construction of multi-level capital market was gradually improved in China, and the role of the financial market in helping the real economy became more and more obvious, providing important help for the further leap-forward development of economy. Although China's financial market started late, it has also become an indispensable part of the world financial market. On September 26, 2020, FTSE Russell, a leading index preparation company, said that the inclusion of Chinese government bonds, as part of the FTSE World Government Bond Index (WGBI), and China's bond trading market will be considered by the world's three major bond

indexes. This announcement will likely bring the incremental capital inflow of trillions of US dollars to the Chinese market, which will have an important impact on the internationalization of RMB and the financial market.

In terms of the development of China's stock market, the Shanghai Composite Index is generally showing an upward trend, and there are also good bull markets. However, the characteristic of "short bull market and long bear market" is more obvious, with strong short-term volatility. During the period from 1990 to early 2001, the stock market was in a relatively long bull market, with short-term fluctuations but an overall upward trend; Around the end of 2001 to 2006, the overall trend of the stock market declined and was in a bear market stage; During the period from 2007 to the end of 2008, there was a sharp rise and fall in the stock market, with significant changes in returns and obvious tail characteristics; Subsequently, at the end of 2008-2014, the stock market was generally in a fluctuating state, and after another peak feature appeared in 2015, it has remained stable and volatile to this day.

The study of the trend of the trading price of the London gold market since 1978 shows that the gold price is relatively stable, and the overall trend is also rising, without excessive fluctuation. Since the beginning of the 21st century, the gold market has entered a slow long bull market, and the gold trading price has been rising for nearly a decade. After reaching its peak in early 2013, there was a continuous downward trend in the following period, and only reentered the bull market around 2015 and remains to this day.

2. Properties

2.1. Related literature

2.1.1. The linkage of the stock market

At present, there are several characteristics of the research on the linkage of the stock market: first, the linkage between China's stock market and the international stock market, and most of the research objects are the linkage between the Hong Kong financial market and Shanghai and Shenzhen stock market. Xie Shiming (2016) used Copula model and association rules to conduct the linkage analysis of A & H shares based on Shanghai-Hong Kong Stock Connect and adopted the official opening of Shanghai-Hong Kong Stock Connect as the demarcation point to study the linkage in stages. Another part of the research is to explore the frequent exchanges between China's stock market and economic trade and developed countries from the perspective of dynamic linkage research[6]. Peng Rui (2019) studied the linkage between the international crude oil market and the Chinese stock market through SVAR model and Copula-Garden model and reached the conclusion of the positive correlation between China's stock market and the international crude oil market[9]. Xia Zhixian (2016) used the time-varying Vine-Copula model of rattan structure, using the C-Vine and D-Vine structure Copula models to depict the correlation between the Asian stock markets, and drew the conclusion that the time-varying Copula model under the C-Vine structure can better describe the correlation of five major Asian stock indexes: Shanghai, Korean Composite and Nikkei[16].

However, the Chinese academic circle studies the stock market and domestic related variables in the following aspects: First, the linkage relationship between China's stock market and bond market, currency market and other financial markets. Luan Jun (2012) proved through the Copula-GARCH model that the stock market and bond market yield are weak and are closely related to the immaturity of the financial market [12]. Li Wanli (2018), based on the time-varying Copula model, proved that the time-varying t-Copula can better describe the correlation between the yield of crude oil and gold market in China, and the tail correlation is asymptotically independent[18].

2.1.2. The linkage between gold market and stock market

Chinese scholars have rich research types of factors for the linkage of gold price changes and the stock market, including the dynamic correlation of assets, the international gold market and stock index, the fluctuation of gold yield, the linkage between precious metal market and the attribute of gold.

Liu Ling (2016) used a time-varying parameter vector auto-regressive (TVP-VAR) model to test the spillover effects of stock and gold returns and conducted tests in stages. She concluded that during economic crises, gold has a haven asset nature in the stock market, while during international gold crashes, the hedging effect of gold on stock market risks weakens, and the spillover direction changes when influenced by typical economic events[20]. Other researchers also divided the international gold price and the US stock index into three stages to study the linkage relationship and considered the impact of the subprime crisis on the spillover effects of the international gold market. He concluded that the position of gold in the international financial market is gradually improving, and the third stage is more in line with the statistical characteristics of the entire sample for the first two.

2.2. Theoretical Mechanism

2.2.1. The development course of the Chinese stock market

In 1984, Beijing Tianqiao Co., Ltd. and Shanghai Feile Co., Ltd. were approved by the central Bank to the public stock issuance, from then on, the first step towards the establishment of a multi-tiered capital market. In the past nearly 40 years, China's stock market has grown from an initial establishment to a large financial market with nearly 3,500 listed companies. Although the stock market is not enough mature market environment, supervision, and management mechanism, but as investors education continues to implement, gradually improve the laws and regulations, and the Shanghai port, the establishment of the system, direct contact with the Hong Kong stock market, makes China's stock market and the world financial market have the reality of linkage.

In March 2016, the registration system was officially implemented. Until February 1, 2023, China's listed companies officially crossed from the examination and approval system to the registration system, and the registration system was fully implemented. The registration system is the so-called open management principle, which is essentially a financial disclosure system represented by the federal securities law of the United States, which requires the companies that issue securities to take the prospectus as the core and provide information about the securities issuance itself and all related information. The examination and approval system requires the issuer not only to fully disclose the real situation of the enterprise, but also to meet the necessary conditions stipulated by the relevant laws and the securities regulatory authorities, and the administrative authorities shall conduct substantive examination of the issuing conditions of the issuer.

The formal establishment of the registration system has both advantages and disadvantages. The positive parts are that IPOs will be more efficient, marketization process faster, and the cost of illegal will be higher. However, at the same time, the drawbacks are also prominent. The regulatory authorities will no longer endorse the registered listing of listed enterprises, investors will bear the responsibility of neglecting the illegal behavior of listed enterprises, and the listed enterprises will lose the former "shell value", and the backdoor listing will gradually withdraw from the stage of history.

2.2.2. The Development history of the world gold market

Gold market refers to the focus of gold and gold exchange market, the current world's important gold market mainly has London, Zurich, New York and Hong Kong, and other places, the London gold market as more than 300 years ago established gold exchange, since 1804 has replaced

the Dutch Amsterdam exchange became the center of the world gold trading, so its trading data, price is more representative.

According to the reserve assets data of the world's major central banks, gold is still an extremely important part of the official strategic foreign exchange reserves in many countries. However, private investment power is the main body of the current world gold trading, mainly retail investors of various investment funds, as well as all types of gold investment brokers, who account for more than 95% of the total trading volume.

In the foreign exchange reserves of central banks, a certain proportion of spot gold is maintained to ensure the stability of their currency exchange rate and the solvency in crisis. Private investment accounts for 95% of the gold market, indicating that gold is an important category of assets in both private and official options.

Gold can be used as a fixed income component of a portfolio, using its monetary properties to preserve value and invest. Especially with the development of innovative derivative financial instruments such as gold futures and structured products linked to gold, the financial attribute of gold has been further enhanced.

At the same time, when the extreme price changes, the linkage between the gold price and the stock market causes wide discussion in the academic circle. When stock market fluctuates violently, whether gold can be a strong safe-haven asset, maintain the stock market volatility stable, even almost independent relationship which is statistically the tail correlation. Therefore, in this paper, the Copula model will be used to study the correlation and the tail correlation.

2.2.3. Interlinkage influence of gold reserves

In some "black swan" extreme events, such as the European debt crisis in 2010 caused the reduction of sovereign credit rating and financial crisis, which made people lose confidence in the credit currency, and the market panic increased. People avoid a fall in the value of their assets, especially financial assets, often lead to panic selling by investors, resulting in a slump in the stock market.

At this point, gold can be used as a stored value asset to become a suitable investment product for investors, and for the supply of gold will not surge or collapse, the trading price of gold will rise. For example, after the subprime mortgage crisis in 2008, the price of gold rose, and the bull market lasted for nearly three years.

Although the correlation between China's stock market and the gold price is relatively low, in the academic research, the Chinese stock market has got a certain linkage relationship with the international stock market after the opening of the Shanghai-Hong Kong Stock Connect and the Shenzhen-Hong Kong Stock Connect, which can influence each other. To what extent gold can be linked with the Chinese stock market is part of the empirical analysis will be later.

The study on the impact of phased linkage is mainly to conduct dynamic model estimation and analyze the impact of lag information set on the current period according to the pulse response, and the purpose is to study the fluctuation spillover and linkage relationship between the research objects during major economic events.

Zhu Jingyu (2012) found that the linkage between the international gold market and the American stock index gradually improved during the three stages of 1976-1986, 1986-1999, 2000-2008, and the position of the gold market in international finance gradually increased[21]. The above documents show that after 2000, the international gold market of China economy has undergone a far-reaching change in its international status; After the global subprime mortgage crisis in 2008, the degree of international trade in China and the connection between China gold market and international gold market also showed a qualitative leap.

To sum up, based on the analysis of the Shanghai Composite Index since the establishment of the Shanghai Composite Index, according to the different degree of internationalization of China,

taking China's accession to the WTO and the subprime mortgage crisis in 2008 as the demarcation point, this paper discusses the degree of internationalization between the international gold market and China's stock market. Therefore, the overall sample is divided into three developmental stages, and the division of the stages will be analyzed below.

(1) The first stage: 1990-2000, local development stage.

Since the reform and opening, China has gradually stepped into the international market. However, before China's entry to the WTO, the total amount of international trade was relatively small, and the Chinese market was still in the stage of "savage growth", which was more obvious for the stock market. China's stock market has been officially open to the public since December 19, 1990. During the local development stage, the various systems of China's stock market are not perfect, the number of listed companies is relatively small, the investor education is poor, and there is only the main board market, which is not large. Judging from this, we proposed that the international gold market in this stage should have a low correlation with the Chinese stock market, and this paper chooses to set this sample space as the first stage.

(2) The second stage: 2000-2008, WTO international development stage.

With China's formal entry into the WTO, the economic exchanges with the developed countries in the world are gradually frequent, and China has gradually become the largest developing country and the "world factory". The import and export volume are rising sharply, and the inflow of international capital has also brought extraordinary power to China's economy.

In addition, China began to plan to build a multi-level capital market. In May 2004, the Shenzhen Stock Exchange set up a small and medium-sized board, and then gradually increased the number of listed companies. Since 2006, the Shenzhen Stock Exchange began to replan the opening of the GEM, indicating that China's stock market is gradually maturing.

At the same time, this stage is also the most "comfortable" stage of China's trade between economy and developed countries, the political risk is relatively low, and China has benefited a lot from it.

(3) The third stage: 2008-2020, New International Trade System Stage.

After the 2008 financial crisis, the economic situation of most developed countries has suffered serious damage, and China is no exception. But at the same time, taking this opportunity, China's international trade gradually left the "fixed" settlement currency, and its usage in international transactions increased significantly.

In addition, the gold market continued to rise at this time. With the improvement of the close connection between China's gold market and the international gold market, its attributes of hedging risks gradually emerged, in sharp contrast to the collapse of the stock market. In 2014, China also formally established the connectivity mechanism of Shanghai-Hong Kong Stock Connect program, which further improved the institutional basis for the linkage between China's stock market and the international stock market.

3. TESTS

3.1. Data

3.1.1. Selection of indicators and sample data

In terms of index selection for empirical analysis, this paper selects the yield of Shanghai Composite Index (000001.SH) representing the yield of the US dollar of the Chinese stock market and the yield of the London gold market. There are several reasons for the choice of such indicators. First, the main board market of the Shanghai Stock Exchange, as the earliest emerging stock market in China, is also the most active stock market in China. The Shanghai Composite Index is the most representative index to best reflect the trading situation of Chinese stock market. Secondly, the London gold market in the world and the dollar is the most used

international trading settlement currency, taking the yield of gold in London market as the consideration index, which can better reflect the trading situation of the international gold market.

In terms of sample data, since the Shanghai Composite Index started on December 19,1990, the daily closing price from December 19,1990 to January 20,2020, and excluding the different trading days of the London gold market and the Shanghai Composite Index, a total of 7,114 daily trading data were selected as the study sample set. Among them, the Shanghai Composite index yield data representing the stock market yield is from the Reith Financial database, while the dollar gold trading yield data representing the London gold trading market is from the official website of the World Gold Council[22]. The measurement software in this paper is EvIEWS 10.0 and Matlab 2020a.

3.1.2. Description of the sample data

Table 3.1: Descriptive Statistic						
N	Mean	Max	Std.D	Skw	Kurt	J-B
7,363	0.48	71.92	2.24	5.32	162.79	786,828
7,363	0.00	0.08	0.01	0.04	10.64	17,933.4

According to the descriptive statistics, the logarithmic yield rate of the Shanghai Composite Index (hereinafter referred to as *Rclpr*) has a clear centralized distribution trend, and according to the results of J-B test, it refuses to meet the original hypothesis of normal distribution.

At the same time, the maximum value of 71.91 and the minimum value of negative 17.91 shown in the statistical table deviate greatly from the other data. According to textual research, the maximum value of 71.91 occurred on May 21,1992, when the Shanghai Stock Exchange fully opened the stock market, because of the overall rise of the stock market, the lowest 604 points, the highest 1,334 points, concussion 730 points, and the daily yield was as high as 105%. The minimum -17.91 occurred on May 23,1995, mainly affected by the "5.18" event of Treasury futures trading, down 147 points, or 16.39% (Due to space limitations, some results haven't been shown in the table).

Although the London gold market yield (hereinafter referred to as *Rusd*) is graphically closer to the normal distribution, the original hypothesis of normal distribution is also rejected according to the J-B test results. Therefore, we need to find other models for the edge distribution of both.

3.2. Copula model

Generally, binary normal Copula functions (hereinafter referred to as *Gaussian*) and Frank Copula (hereinafter referred to as *Frank*) functions are suitable for two-dimensional random vectors with symmetric tail and asymptotically independent tails; binary t-Copula functions are suitable for two-dimensional random vectors with symmetric tails; binary Gumbel Copula (hereinafter referred to as *Gumbel*) functions are suitable for two-dimensional random vectors with asymmetric tails and asymptotically independent tails; binary Clayton Copula (hereinafter referred to as *Clayton*) functions are suitable for two-dimensional random vectors with asymmetric tail and lower tail asymptotically independent tails.

Figure 3.1: It can be seen from Figure 3.1 binary frequency number histogram, the overall data cannot be clearly observed has symmetry, so you can choose the Gaussian-copula, t-Copula model to study the symmetry properties, using Archimedes Gumbel-Copula, Clayton-Copula model to study the asymmetry characteristics, and then consider the goodness of fit of the Copula model under the standard of square Euclidean distance.

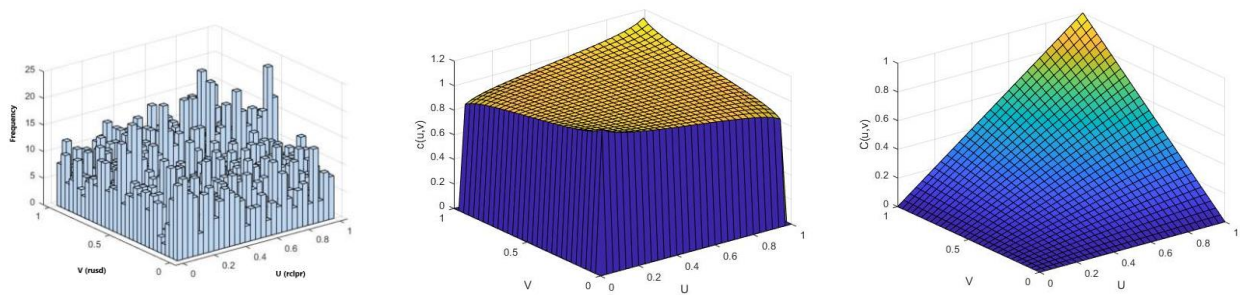


Figure 3.1: Overall Sample, Frequency & The bivariate normal Copula Density Function & The bivariate normal Copula Distribution Function

3.3. Overall sample Copula model parameter estimation

According to the results of the distribution analysis of *Rclpr* and *Rusd* sequences, the kernel distribution estimation is used to find the edge distribution of random variables *U* and *V*, and then calling the copula-fit function in Matlab to estimate the parameters in the Copula model will be used as the empirical research method in this paper.

In the obtained results, in the t-Copula, the contour likelihood is not negative to estimate the confidence interval, so the t-Copula model is not applicable to estimate the confidence interval.

1Table 3.2: Overall sample parameter estimation results

Overall	Rho	Kendall	Spearman	Alpha	interval	D2
Gaussian	0.05	0.03	0.04	-	-	0.19
t	0.05	0.03	0.05	-	-	-
Clayton	0.02	-	-	0.05	[0.02,0.08]	0.24
Gumbel	0.02	-	-	1.022	[1.01,1.04]	0.21

1Table 3.2: Overall sample parameter estimation resultsIn Table 3.2, the square Euclidean distance of the Gaussian-Copula model is 0.194. Compared to the asymmetric one, the square Euclidean distance of the Clayton-Copula, Gumbel-Copula functions, which have a smaller distance from the empirical distribution function. Thus, the linear correlation parameter is 0.046. The Gaussian-Copula model, under the square European distance standard, can better fit the daily yield observation data of Shanghai and international gold markets.

As can be seen from Figure 3.1 of the bivariate normal Copula density function, the whole is close to the cuboid, but the upper and lower tails are slightly correlated, but because the bivariate normal Copula model does not have a tail correlation, the t distribution cannot be estimated in this sample. Therefore, the lower tail correlation coefficient measured by Gumbel-Copula is 0.508, which indicates that when the random variable shows a violent downward fluctuation, it will have an impact on the value of another random variable, that is, the lower tail correlation.

3.4. Stage-wise Linkage

3.4.1. The first stage, The initial local development of the capital market.

During the 1990s, China had just entered the development period of reform and opening, and its capital market was initially opened. Currently, the domestic financial market and capital market policies are relatively conservative, and the international trade is less, mainly to the local economic development. Therefore, the time interval selected in this paper is from December 19,1990 to December 10, 2001, with a total of 2,718 sample values, to fit the Copula model.

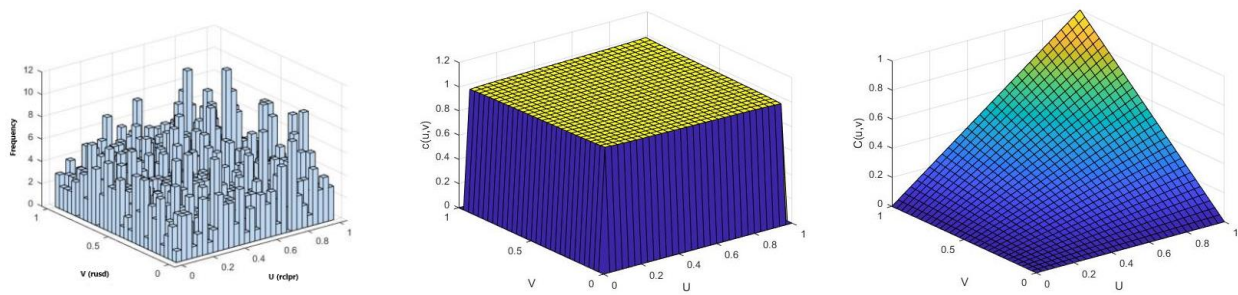


Figure 3.2: The first stage, Frequency & The bivariate normal Copula Density Function & The bivariate normal Copula Distribution Function

According to Figure 3.2 binary frequency number histogram - The first stage, the joint distribution of (U, V) does not have obvious symmetry, so the four models are fitted separately in this stage.

2Table 3.3: Sample parameter estimation results in the first Stage

Stage 1	Rho	Kendall	Spearman	Alpha	Interval	D2
Gaussian	0.01	0.003	0.01	-	-	0.14
t	0.01	0.003	0.01	-	-	-
Clayton	0	-	-	0	[-0.4,0.4]	0.15
Gumbel	0	-	-	1	[0.99,1.02]	0.14

Stage 1	Rho	Kendall	Spearman	Alpha	Interval	D2
Gaussian	0.01	0.003	0.01	-	-	0.14
t	0.01	0.003	0.01	-	-	-
Clayton	0	-	-	0	[-0.4,0.4]	0.15
Gumbel	0	-	-	1	[0.99,1.02]	0.14

From Table 3.3., the t-Copula distribution is the same as the estimated result in the overall sample, which cannot obtain the confidence interval results, and thus is not considered. Whereas the Gaussian-Copula, the linear correlation coefficients of Clayton-Copula and Gumbel-Copula are, respectively 0.005, 7.254e-07, 8.7977e-04, All of these showed a very low correlation.

Under the square Euclidean distance standard, the linear correlation parameter of 0.005 is also the most appropriate binary normal Copula model. In Figure 3.2, the first stage-binary normal Copula density function, the density function is almost cuboid, which also indicates that the sequence yield is asymptotically independent under this stage sample, which is also proved by the small absolute value of the linear correlation parameter.

Using the parameters of Archimedes family function Clayton-Copula and Gumbel-Copula, the upper tail correlation coefficient is infinitely close to 0, while the lower tail correlation coefficient is 0.50. There is a lower tail correlation under the Gumbel-Copula model, when a random variable takes a small value, it will have an impact on the value of another random variable.

3.4.2. The second stage, WTO, and the internationalization process begins.

The sample time interval of the second phase was selected from 11 December 2001 to 09 September 2008, with a total of 1,632 observations.

From Figure 3.3, The binary frequency number histogram of the second stage, the binary frequency number histogram shows no obvious asymmetry, and the tail is uncharacteristic. Therefore, it can be fitted by the Gaussian-Copula, t-Copula, and Frank-Copula models.

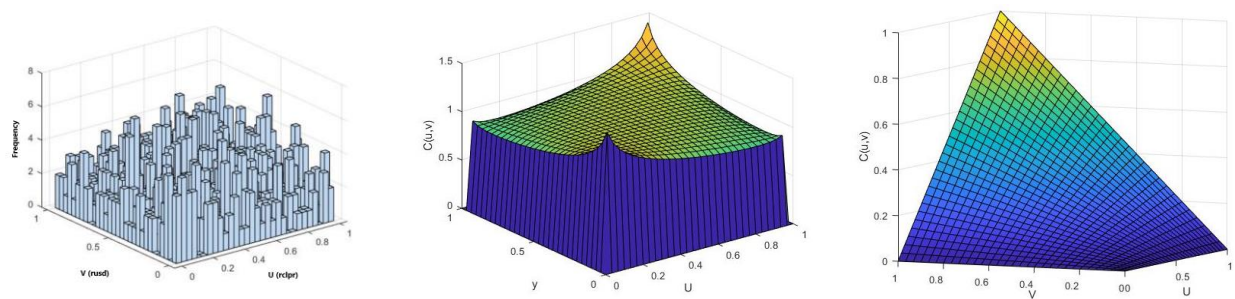


Figure 3.3: The second Stage, Frequency & The bivariate normal Copula Density Function & The bivariate normal Copula Distribution Function

3Table 3.4: Sample parameter estimation results in the second Stage

Stage 2	Rho	Kendall	Spearman	Alpha	Interval	D2
Gaussian	0.07	0.05	0.07	-	-	0.11
t	0.08	0.05	0.07	-	[1.01,1.07] (nuhat=18)	0.1
Clayton	0.04	-	-	0.09	[0.03,0.14]	0.13
Gumbel	0.04	-	-	1.04	[1.01,1.07]	0.12
Frank	0.05	-	-	0.29	[0.18,0.77]	0.1

3Table 3.4: Sample parameter estimation results in As can be seen from the results of sample parameter estimation in Table 3.4., t-Copula has the minimum distance under the square European distance standard, indicating a linear correlation coefficient of 0.762, degrees of freedom of 18, and confidence interval of within the [1.006,1.0665] results, the t-Copula model can be relatively well fit *Rclpr*、*Rusd* order.

According to the symmetry characteristics of the upper and lower tails of the t-Copula model, the upper and lower tail correlation coefficient is 0.001. It shows that when a random variable takes large or small extreme values, it will influence another random variable, that is, there is a weak tail correlation between the two random variables under the t-Copula model.

3.4.3. The third stage, The new internationalization era

In the third stage, after the outbreak of the financial crisis in 2008, due to the impact of developed economies to varying degrees, and the government debt ratio of sovereign countries began to rise continuously, the global anti-globalization trend began to appear. Therefore, the sample time interval was selected is from September 10,2008 to January 20,2020.

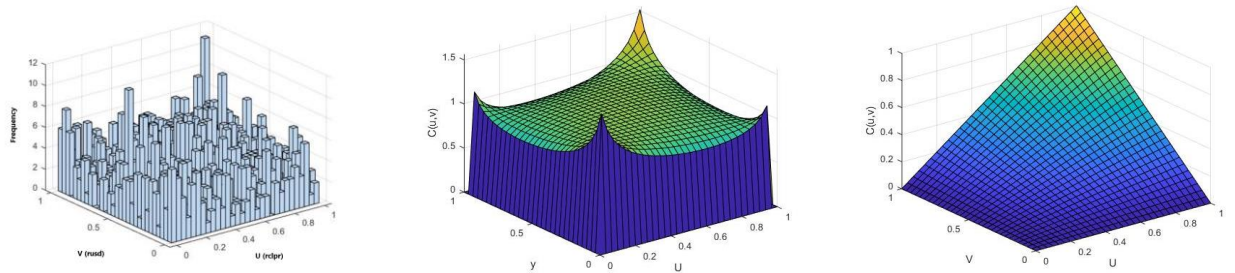


Figure 3.4: The third Stage, Frequency & The bivariate normal Copula Density Function & The bivariate normal Copula Distribution Function

From 错误!未找到引用源。 Figure 3.4, the third stage shows that the joint distribution function of random variables does not have obvious symmetry, so five Copula are fitted one by one in this stage.

4Table 3.5: Sample parameter estimation results in the third Stage

Stage 3	Rho	Kendal	Spearman	Alpha	Interval	D2
Gaussian	0.06	0.04	0.06	-	-	0.02
t	0.06	0.04	0.06	-	[5.36,11.5] (nuhat=8.42)	0.01
Clayton	0.04	-	-	0.07	[0.03,0.11]	0.02
Gumbel	0.04	-	-	1.04	[1.02,1.07]	0.03
Frank	0.04	-	-	0.30	[0.12,0.56]	0.03

4Table 3.5: Sample parameter estimation results in As can be seen from Table 3.5 for the third stage sample parameter estimation results, The linear correlation parameters between Gaussian-Copula and t-Copula were 0.058 and the rank correlation coefficient was 0.037, while the three fitting parameters of Archimedes Copula model were between 0.03 and 0.05.

Follow Table 3.5, t-Copula also has the smallest square Euclidean distance in this stage, so the t-Copula model with linear correlation coefficient of 0.058, degree of freedom of 18, and upper and lower tail correlation coefficient of 0.02 can better fit the original data.

3.5. Estimation Results

3.5.1. Overall sample estimation results

1According to Table 3.2, the binary normally distributed Gaussian-Copula model has the smallest square Euclidean distance, also indicated for the original sample *Rclpr*, *Rusd*. The fit effect is better. Its linear correlation parameter Rho is 0.046, and its rank correlation coefficient Kendall and Spearman are 0.029 and 0.044, respectively.

According to Figure 3.1, the 3D image of the density function of binary normal Copula is close to the cuboid, and the whole is approximately evenly distributed. Therefore, it can indicate that they are approximately independent of each other, and their influence is very small.

3.5.2. Sample estimation results in the first Stage

Stage 1	Rho	Kendall	Spearman	Alpha	Interval	D2
Gaussian	0.01	0.003	0.01	-	-	0.14
t	0.01	0.003	0.01	-	-	-
Clayton	0	-	-	0	[-0.4,0.4]	0.15
Gumbel	0	-	-	1	[0.99,1.02]	0.14

According to Table 3.3, the Copula model estimate in the first stage is like the overall comparison, and the confidence interval of t-Copula cannot be estimated, and the statistical efficacy is low. However, the binary normal Copula value has the smallest squared Euclidean distance, which can better fit the original data.

The difference from the overall sample estimate is that the correlation coefficient Rho, Kendall, Spearman, indicating that the correlation is very low and almost negligible in this sub study sample.

However, it can be seen from the density function of binary normal Copula in Figure 3.2 that the whole is closer to the cuboid compared with the density function of the population sample, which also complies with the conclusion of low correlation and approximately independence.

3.5.3. Sample estimation results in the second Stage

3According to Table 3.4, the t-Copula model has smaller square Euclidean distance, so the t-Copula model with linear correlation parameters of 0.076, rank-correlation coefficient Kendall of 0.049, Spearman coefficient of 0.072, and degrees of freedom of 18 can better fit the original data than the other models.

It is also evident from the Figure 3.3 t-Copula density function plot Rcplr and Rusd. Which means the empirical research results support that there is a strong tail correlation in the second Stage.

3.5.4. Sample estimation results in the third Stage

4According to Table 3.5, the t-Copula model has a smaller square Euclidean distance, indicating that the t-Copula model with linear correlation parameter Rho of 0.058, rank correlation coefficient Kendall of 0.037, Spearman coefficient of 0.055 and 8 degrees of freedom can better fit the original data at this stage.

The results of the binary t-Copula model and all three kinds of correlation coefficients of Gaussian-Copula are very similar, suggesting a symmetric correlation in the tail of the joint distribution of the original data. Like the second Stage results, Figure 3. shwos t-Copula density function map also clearly shows the tail symmetry-dependent properties.

4. Conclusion and outlook

4.1. Conclusion

4.1.1. Linkage relationship between

Under the fit of binary normal Copula model, it can be concluded that in 1990 to 2020, the Shanghai composite index and the London gold market dollar yield linkage between yields is weak, the reason is that the Chinese stock market in a long stage in local development stage, and until 2014 opened the Shanghai port connectivity mechanism, open the door for China's financial internationalization and liberalization. In addition, due to the strict regulation of China's foreign exchange market, gold, as an anti-inflation financial product, has a strong correlation with currencies. Therefore, the international gold market has a weak impact on China's domestic currencies and has little impact on China's stock market.

4.1.2. Linkage relationship in stages

(1) China's stock market at the local stage

The parameter estimation results of the binary normal Copula model show that the correlation is weak and extremely low during the period from 1990 to 2000. The reason is that the Chinese stock market was just established at that time, and the overall structure, the number of investors, the system and other aspects were not sound, and it had nothing to do with internationalization. Therefore, the model shows the conclusion that the two are gradually independent.

(2) The WTO era, China begins the process of internationalization

The results of the binary t-Copula model show that during the period from 2000 to 2008, the correlation between the Shanghai Composite Index and the London gold trading yield increased significantly more than before. The main reason is that after China's accession to the WTO World Trade Organization, the trade degree with various developed economies in the world has gradually increased, and the RMB has thus entered the process of internationalization. Since the RMB is not the main settlement currency for international trade, Chinese investors generally need to settle in US dollars to buy gold in the international market.

And the empirical study shows that the two have a certain tail correlation, indicating that when the international gold market and China's stock market have obvious fluctuations, the correlation between the two will be significantly enhanced.

(3) The post-financial crisis era

The results of binary t-Copula model show that from 2008 to 2020, there is a weak correlation between Shanghai Composite Index and London gold market, but the tail correlation has increased significantly compared with before the financial crisis. The reason is that the linkage between the gold market and the stock market is generally low, and there is no obvious correlation. As the degree of internationalization in China has been significantly improved compared with before, the process of financial liberalization has also been significantly accelerated with the establishment of the Shanghai-Hong Kong Stock Connect program, Shenzhen Connect Shenzhen-Hong Kong Stock Connect interconnection mechanism and the gradual relaxation of foreign capital control, and the linkage between the China stock market and the international stock market has also been enhanced. Therefore, in extreme events, the China stock market, like foreign stock markets, will have a correlation with fluctuations in the gold market.

4.2. Suggestions and inspirations

As can be seen in this paper, China, as the largest developing country, its economic strength is accompanied by the closer ties with countries in the world. Adhering to the concept of building a "community with a shared future for mankind", we hope to achieve it through a double win way in our cooperation with other countries. However, while sharing the fruits of economic development, it will also share the subsequent risks in the development process. Since the first economic crisis in the United States in 1933, the number of financial crises has become more frequent, gradually spread to the world, and the harm has become more serious.

Therefore, in the conclusion of this paper, gold is less associated with the China stock market, which can be used as a stable anti-inflation product in the portfolio to achieve the purpose of allocating asset portfolio. On the other hand, it should be noted that the linkage between Chinese stock market and foreign market is rising, and the rising tail correlation shows that the spillover effect of the international market is increasing with the gradual development of Chinese economy. We need to be alert to the risks of abnormal events in other countries and regions.

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