Dynamic Research on Risk Contagion of China's Stock Market, Bond Market and Foreign Exchange Market Based on MS-DCC Model

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Abstract: In recent years, economic growth has slowed down, systemic risk pressures have increased, financial markets have gradually opened up, and the financial system has faced new problems and challenges. The degree of risk correlation and contagion between financial markets is of particular concern. In this paper, by adopting the Markov three-zone state transition model and the dynamic correlation coefficient model, the risk dynamic relationship between China's stock, national debt and exchange rate market volatility and various market risks during 2005-2018 is explored, which provides a reference for the measurement and supervision of systemic financial risks in China. The experimental results are as follows: 1. From the perspective of its own risk characteristics, the stock market has three states of low, medium and high volatility, and the high school risk duration is 4.2 times of the low risk duration. The bond market and the exchange rate market are in a state of low to medium volatility, the exchange rate market risk conversion is more frequent, and the risk duration is shorter. 2. In major financial risk events such as the financial crisis, market risks are different, but risk aversion is the main motivation. 3. For the exchange rate, the bond market has a more serious market segmentation, and a more independent regulatory policy can be adopted. There is a clear risk correlation between the stock market and the other two markets. It is necessary for regulators to consider and conduct systematic supervision on a global scale.

1. Introduction

In recent years, China's economic growth slowdown, economic restructuring, local economic imbalances and other issues have brought more risk pressure to the financial market. How to prevent systemic risks and curb the rapid spread of financial risks has become an important issue. Under the background of solving financial risks and preventing systemic risks, it is important to study the dynamic characteristics of the three major markets and measure the dynamic changes of risk correlation among markets. It is of great significance to adopt differential risk supervision for the stage of correct cognitive risk transmission [1].

Many scholars believe that the increase in stock market risk will force investors to deploy new asset portfolios, reduce stock ratios, increase the allocation of low-risk assets such as bonds, and ultimately cause risks to shift from stock market to bond market. Baur & Lucey (2009) empirical research believed that the United States and the United States and other developed countries in the US subprime mortgage crisis in 2007 led to a significant negative correlation between the stock and bond markets during the global financial crisis. The empirical evidence of Yuan Chen (2010) showed that when China's financial market is in a systemic financial crisis [2], there is a significant transfer of security investment between the two markets. However, Illmanen (2003) and Robert et al (2005) found that stock and bond yields showed positive and negative correlations at different times, and excessive stock market volatility was the cause of the change in the correlation of stocks and bonds. Cuestas & Tang (2017) research showed that the asymmetric phenomenon of the stock market is different with the changes in the industry, and the stock index yield can respond quickly to changes in the exchange rate [3].

Wong (2017) found that the correlation between exchange rate and stock return rate in Southeast Asian countries showed an increasing trend during the financial crisis. Chen Chuanglian and Zhang Nianhua (2017) believed that the short-term impact of the bond market shock on the exchange rate market and the stock market is negative [4], and the long-term impact is minimal. In this paper, the

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dynamics of the three major market risk contagions have been highlighted. With the adjustment of China's economic structure and the deepening of financial reforms, the three major market relationships of stocks, bonds and foreign exchanges have emerged with new features. Dynamic measurement of risk transmission in the three major markets is conducive to a deep understanding of risk communication mechanisms and channels between markets, which does contribute to facilitate regulators to coordinate the supervision of the financial system and curb systemic financial risks [5].

2. Research Design

The Shanghai and Shenzhen 300 Index, the Shanghai Stock Exchange Index, and the RMB against the US dollar are used to represent China's stock market, national debt market and exchange rate market, respectively. Monthly data for July 2005-November 2005 are selected from the wind database [6].

The dynamic conditional correlation coefficient model proposed by Engle(2002)[27] is used to estimate the dynamic correlation between the various asset returns sequences. Assuming that there are k kinds of assets, the yield r_t obeys the mean value of 0, and the multivariate conditional normal distribution of the covariance matrix H_t, ie $r_t|I_{t-1} \sim N(0, H_t)$. The dynamic condition correlation coefficient structure is as follows:

$$H_t = (h_{ij,t}) = D_t R_t D_t \tag{1}$$

Among them, $D_t = \mathrm{diag}\{\sqrt{h_{11,t}}, \sqrt{h_{22,t}}, \cdots, \sqrt{h_{nn,t}}\}$

$$R_t = diag\left\{\frac{1}{\sqrt{q_{11,t}}}, \frac{1}{\sqrt{q_{22,t}}}, \cdots, \frac{1}{\sqrt{q_{nn,t}}}\right\} Q_t diag\left\{\frac{1}{\sqrt{q_{11,t}}}, \frac{1}{\sqrt{q_{22,t}}}, \cdots, \frac{1}{\sqrt{q_{nn,t}}}\right\} \tag{2}$$

Among them, $q_{ij,t} = (1-\alpha-\beta)\overline{q_{ij}} + \alpha\varepsilon_{i,t-1}\varepsilon_{j,t-1} + \beta q_{ij,t-1}$, $\varepsilon_t = D_t^{-1} r_t$; $\overline{q_{ij}}$ is the unconditional correlation coefficient calculated from the standardized residuals. α and β are the coefficients of the DCC model, which represent the pre-normalized residual squared coefficient and the pre-conditional heteroskedastic coefficient in the multivariate GARCH model, respectively satisfying α>0, β>0, α+β<1.

3. Empirical and Analytical

Table 1 Markov three-zone conversion model estimation results

	Stock	Bond	Exchange rate
p_{11}	0.9342*** (0.0579)	0.9939*** (0.0073)	0.9305*** (0.0389)
p_{12}	0.0658 (0.0579)	0.0061 (0.0073)	0.0695* (0.0389)
p_{21}	0.0000 (0.0000)	0.0095 (0.0131)	0.1586** (0.0661)
p_{22}	0.9747*** (0.0201)	0.9905*** (0.0131)	0.8414*** (0.0661)
p_{31}	0.0239 (0.0237)	0.0005*** (0.0000)	0.0024 (0.0954)
p_{32}	0.0205 (0.0250)	0.6065 (0.4685)	0.2714 (1.5324)
σ_1^2	0.0006*** (0.0002)	0.0002*** (0.0000)	0.0003** (0.0001)
σ_2^2	0.0030*** (0.0005)	0.0001** (0.0000)	0.0001* (0.0001)
σ_3^2	0.0147*** (0.0030)	0.0024 (0.0300)	0.0181 (0.2499)
Loglikelihood	-195.9829	-746.9172	-591.2082

Note: * indicates significant at 10%, ** indicates at 5%, and *** indicates significant at 1%.

$\sigma_1^2, \sigma_2^2 \text{ and } \sigma_3^2$ respectively represent the unconditional variance of the asset's return rate in the three low, medium and high fluctuation states.

First, the Markov three-zone system is adopted to convert the model for parameter estimation (Table 1). It can be seen that the large probability of China's stock market shows a medium-high volatility normal, and the bond and exchange rate markets show a low volatility normal [7].

Table 2 shows the average duration of the volatility of each market to maintain low, medium and high volatility, and there is no high volatility duration in the bond and exchange rate markets. The average duration ratio of high volatility, medium volatility and low volatility in stock market is about 1.5:2.7:1. In bond market and exchange rate market, the average duration ratio of low volatility is about 0.64 and 0.7, respectively. The foreign exchange market is in a state of low volatility for 70% of the time, in line with China's long-term history of maintaining exchange rate stability [8].

Table 2 Average duration of each asset under different fluctuations

Average Duration	Stock	Bond	Exchange rate
d_1	15.1976	163.9344	14.3885
d_2	39.5257	105.2632	6.3052
d_3	22.5225	--	--

Note: $d_i = 1/(1-p_{ii}), i = 1,2,3$ indicates the average duration of the three fluctuations of low, medium and high respectively.

In the Markov model, the dynamic transformation of the three major market risks is more accurately portrayed, but the risk contagion of the three major markets is not answered. In this section, based on the DCC model, the risk contagion issues of the three financial markets are analyzed. Table 3 shows the statistical characteristics of the correlation between stocks, bonds, and exchange rate asset volatility. From the average value, the dynamic correlation coefficients of stock-bond, stock-exchange rate, and bond-exchange rate all show negative correlation. The bond-exchange rate market has the most stable correlation, and the risk correlation between the stock and bond markets is the most unstable.

Table.3 Basic statistical characteristics of dynamic correlation coefficients

Statistics	Minimum	Maximum	Mean	Standard deviation
Stock-bond	-0.0547	0.0127	-0.0062	0.0146
Stock-exchange rate	-0.0380	0.0257	-0.0040	0.0140
Bond-exchange rate	-0.0053	0.0023	-0.0007	0.0014

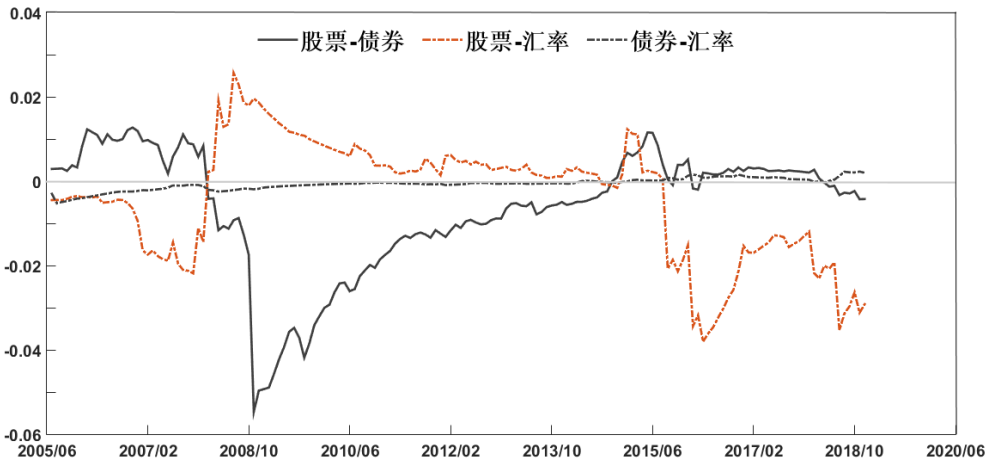

Fig.2. Dynamic correlation coefficient between assets yield

Figure 2 is a graph showing the dynamic correlation coefficients of stocks, bonds, and exchange rate assets. It can be seen that the correlation coefficient between stock-bond volatility fluctuates between -0.06 and 0.02. In the bull market, the two markets show weak positive correlation. From February 2008 to May 2014, the two markets were negatively correlated, that is, the stock market risk increased and the bond market risk decreased. This conclusion is in agreement with the study

by Baur & Lucey (2009) and Yuan Chen (2010). Before 2008, China's long-term implementation maintained the weak value of the RMB, and its export was the main force of China's economic growth. The stock market performed well. After the 2008 financial crisis, global safe-haven funds sought a safe haven for China. The RMB was greatly appreciated in 2008-2014, exchange rate volatility was intensified, stock market volatility was affected by hot money, and the volatility was fierce. There was a positive correlation between the two. The bond-exchange rate market did not show significant risk correlation, mainly determined by factors such as the size of the bond market and the operational characteristics of the foreign exchange market itself. Since China has not yet cultivated the bond interest rate as the market benchmark interest rate, foreign exchange has entered a two-way wave era but the volatility is limited. Therefore, the interest rate parity and arbitrage relationship between the two markets are mature and the market segmentation is more serious.

4. Conclusion

In this paper, through comprehensive analysis of the three major markets, the following conclusions are drawn.

(1) The risk cycles of the three major markets vary widely. In the stock market, the low risk cycle is 15 months, the medium risk cycle is 49.5 months, and the high risk cycle is 22.5 months. The medium-high risk cycle is long while the low-risk cycle is short. The bond market has a low risk cycle of 163.9 months and a medium risk cycle of 105 months. The exchange rate market has a low risk period of 14.4 months and a medium risk period of 6.3 months. The risk conversion frequency is relatively frequent.

(2) In major financial risk events such as the financial crisis, market risks are different, but hedging is the main motivation. Under normal circumstances, the risk correlation between the stock market and the bond market is small, but in the high-risk stage, the bond hedging property is highlighted. There is a significant negative correlation between the two markets, and stock and exchange rate fluctuations are positively correlated. As China's economic growth slows and the unilateral appreciation of the RMB ends and exchange rate risks increase.

(3) There is segmentation in the market and regulation should be adjusted. Due to the relatively severe market segmentation in the exchange rate market and the bond market, in the prevention of the risks of the two markets, the "Ding Bogen Principle" can be used to adopt a relatively independent regulatory policy. However, there are obvious risk correlations between the stock market and the other two markets. It is necessary for regulators to focus on monitoring the stock market and prevent stock market risk spillover effects.

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