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Interbank Market Interest Rate Risk Measure An Empirical Study Based on VaR Model

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ABSTRACT

In this paper, we use the VaR model to study the daily weighted average interest rate of the interbank market in China from January 4, 2013 to October 30, 2014, and establish the interest rate risk measure of China's interbank lending market based on GARCH model (GARCH (1,1) / TARCH (1,1) / EGARCH (1,1)), the following conclusions are drawn: t distribution is not suitable for describing the distribution of interbank lending rate series in China, the generalized error distribution Which can better describe the distribution of interbank lending rates in China. According to the sample data, the risk of interbank lending rates at the present stage is also low.

KEYWORDS: VaR model; interbank market lending rate; GARCH family model

1. Introduction

Interbank market is a short-term, temporary position between the financial institutions to adjust the market, is an important part of the money market. Since 1996, the Bank of China interbank market has been developing steadily under the supervision and management of the People's Bank of China. At present, it has formed a unified pattern of interbank lending market, resulting in a unified national inter-bank lending rate, CHIBOR), which is the earliest market interest rate in China's money market and is currently the only direct market interest rate, which can be very sensitive to the supply and demand of monetary funds on the market, so it can be regarded as the benchmark interest rate in the Chinese money market.

With the deepening of interest rate marketization, the perfection and rationalization of interest rate structure system, the maturity of China's financial market and the richness of financial derivatives, the experience of commercial banks in interest rate risk management is gradually mature. Commercial banks can gradually evolve into advanced interest rate risk measurement models. And thus with the international advanced risk management level, and enhance their own market competitiveness and ability to resist risks. The interbank lending is the forefront of China's interest rate market reform, interbank market lending market interest rate market reform began in 1996, interbank interest rate marketization has been higher, with the use of VaR model objective conditions. Coupled with the VaR model is already a relatively mature model, use it to study the interbank lending market should be a certain research value.

The VaR model is derived from the basic mean-variance model founded by Markowitz in 1952, and Till Guldman is regarded as the founder of the term 'risk value', which has been rapidly gained by scholars The Jeremy Berkowitz (1999) proposed a new approach to evaluate VaR, Tean-Philippe Bouchaud and Marc Poters (1999) proposed how to use the normality of financial asset volatility, which is a very mature theoretical and empirical study of VaR abroad. Which is based on the assumption that the financial time series data are subject to normal distribution and unconditional variance. However, a large number of empirical studies show that the financial time series data and the financial time series data are used to calculate the VaR values. In order to solve this problem, with the deepening of the research, some scholars put forward the semi-parametric model and the generalized conditional heteroskedasticity model (GARCH model) and so on, which greatly enriched the calculation method of VaR. Kees Koedijk (2001) applied the VaR risk management model to portfolio selection and capital asset pricing, noting that the portfolio yield rate showed a spikes, which would lead to an underestimation of the traditional mean-variance model with an underestimated risk portfolio Risks that may lead to investment risks.

In recent years, there are scholars in China, Wang Chunfeng, Wan Haihui and Li Gang pointed out that the Monte Carlo simulation method to calculate the VaR value of the shortcomings of the existence of the VaR value, and proposed based on the Markov chain Monte Carlo calculation method. After a number of scholars have put forward the improvement of VaR calculation method, at the same time, VaR method of application research began to receive attention. Du Haitao (2000) in the 'VaR method in the application of securities risk management,' a paper in the market index risk measurement, a single securities risk measurement, fund managers performance evaluation and determine the placement price and other aspects of the use of VaR method. He believes that the Shanghai and Shenzhen cities index. The gains of individual securities and investment funds are subject to the normal distribution. Under this premise, the VaR value of the assets is calculated and the model test is carried out, and good results are obtained. Taking his research as the representative, the early empirical research on VaR focused on the securities market. So far, the use of the VaR approach to the interbank market has not yet been rich, but as far as I have said, the interbank market is becoming more and more important in the face of major financial market reforms in China It is necessary to carry out the risk measurement analysis.

Under the existing research, Zheng Yao-tian and Du Zhiping (2007) selected the overnight lending rate as the research object and modeled them by the combination normal VaR method and the Monte Carlo simulation method respectively. The Monte Carlo simulation method (2009) from April 4, 2002 to March 31, 2009 during the period of the Bank of China interbank interest rates as the object of study were established overnight and 7 days of borrowing varieties of the forecast model, and measure its interest rate risk. It is found that the ARMA-GARCH model with appropriate lag order can effectively characterize the dynamic characteristics of the interbank interest rate: the t-distribution and g-distribution models can better capture the spikes of the interbank interest rate sequence There is a significant correlation between the interbank interest rate, the risk premium effect and the anti-leverage effect of the volatility, that is, the volatility of the interest rate increases, and the VaR method can effectively predict the interbank interest rate risk. Most of the research is about the GARCH model to expand the development of research, and come to a different conclusion.

2. Analysis on the Current Situation of China's Inter - bank Interbank Market Rate and Model Establishment

June 1, 1996, the People's Bank of China abolished the upper limit of the interbank lending rate, interbank interest rates by the parties to the transaction according to market supply and demand situation to determine their own, began the market with China market lending reform. In 1996, the trading volume of the market was only 587.558 billion yuan, and the transaction volume reached 2,811.3 billion yuan in 2003, the interbank market is growing rapidly. With the surge in market volume, the uncertainty in interbank lending rates has increased. The participating commercial banks face huge interest rate risk. Although the borrowing of funds is only short-term use, but in reality the commercial bank lending funds have been removed the demand for swap positions, interbank lending funds are in interest rate risk. Therefore, it is valuable to use the VaR model to measure the interest rate risk of Chinese commercial banks in the interbank market.

(1) Data and its source

As a result of the overnight split in the interbank market, I chose the latest data, which is the daily weighted interest rate of the interbank market from January 4, 2013 to October 30, 2014. Observations are sample data, some of which are missing data (data source for the Eastern Fortune Network Data Center http://data.eastmoney.com/shibor/shibor.aspx?m=ch\u0026t=98\u0026d=99231\u0026cu=cny\u0026type=009086\u0026p = 24).

(2) Descriptive statistical analysis

Before using the VaR model to measure interest rate risk, the data should be analyzed and statistically analyzed and the normality, stability, autocorrelation and conditional heteroskedasticity of the interbank interest rate sequence should be tested first.

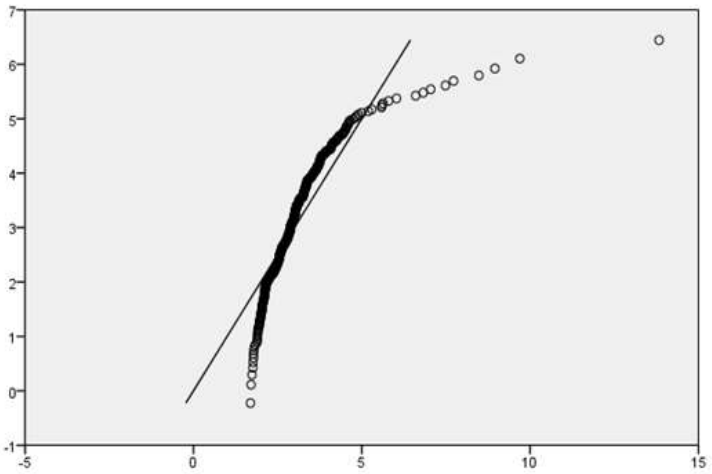
1. Descriptive statistics

It can be seen that the minimum interest rate in the interbank offered rate is 1.6922% and the maximum interest rate is 13.8284%, which is very large, which also confirms the risk of the interbank market. Interbank rates were 3.109752%. On the other hand, from the table to see the interbank interest rate skew for 3.669, for the right deviation distribution; peak degree of 24.529, the data for the peak distribution.

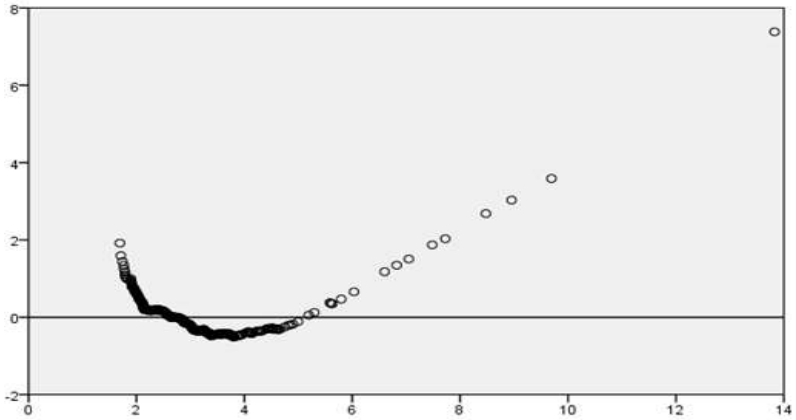
2. The normality test

Normal sample of the QQ and the trend without the normal probability of the following chart, through the normal probability map can be seen in the normal line outside the distribution of a large number of points, the data points of the line was curved, and both ends of the Swing, indicating that the actual distribution of CHIBOR has thick tail on both sides. Through the trendless normal probability graph, we can see that most of the scatter is not randomly distributed

around the horizontal straight line through the zero point, but rather the obvious parabolic shape. Therefore, the normal QQ graph and the trendless normal probability graph can be preliminary It is assumed that the data obey the normal distribution hypothesis is not established.



The results are shown in the following figure. From the results, it can be seen that the mean value of the sample data is 3.109752, the standard deviation is 1.1130473, the Z statistic of KS is 3.304, the corresponding probability is 0.000, the significance level is less than 0.05, Therefore, the normality hypothesis is rejected, and the actual distribution of interbank interest rates and the normal distribution there is a significant difference.



Through the above test, the interbank offered rate distribution in China is non-normal, and if it still assumes that it is subject to normal distribution, although the operation can be greatly simplified, the error will be relatively large. Thus, we use other distributions instead of the normal distribution to improve the fit of the model.

3. The stability test

The CHIBOR unit root test, test results are as follows, we can see that the ADF statistic value of -3.978563, P value of 0.0017, so reject the original hypothesis, indicating that CHIBOR data is stable.

Null Hypothesis: CHIBOR has a unit root

Exogenous: Constant

Lag Length: 7 (Automatic - based on SIC, maxlag = 17)

4. Self-correlation test

The purpose of the autocorrelation test is to test whether the lending rates of each period are relevant. For the autocorrelation test method, there are mainly sequence correlation method represented by Dickey-Fuller test and sequence correlation test based on Ljung-Box statistic.

Using the EViews to find the autocorrelation coefficient and the partial correlation coefficient of the CHIBOR sequence and the Ljung-Box statistic Q-t results are as follows:

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.978563	0.0017
Test critical values:	1% level	-3.444691	
	5% level	-2.867757	
	10% level	-2.570145	

Sample: 1 457
Included observations: 457

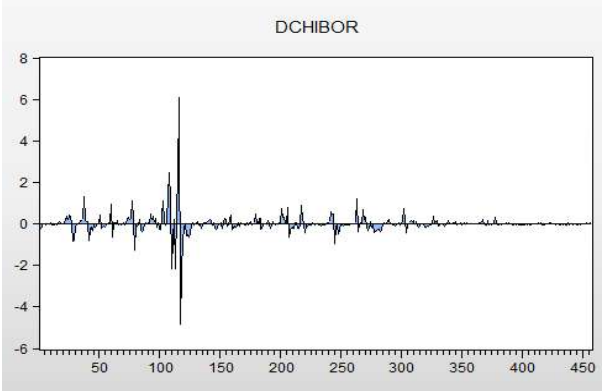
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.896	0.896	369.01	0.000
		2	0.779	-0.117	648.86	0.000
		3	0.702	0.141	876.73	0.000
		4	0.669	0.154	1083.9	0.000
		5	0.631	-0.038	1268.8	0.000
		6	0.597	0.070	1434.7	0.000
		7	0.576	0.076	1589.5	0.000
		8	0.518	-0.210	1714.9	0.000
		9	0.444	-0.048	1807.2	0.000
		10	0.388	0.029	1877.8	0.000
		11	0.362	0.016	1939.2	0.000
		12	0.340	0.005	1993.6	0.000
		13	0.305	-0.033	2037.5	0.000
		14	0.254	-0.105	2068.0	0.000
		15	0.210	0.034	2089.0	0.000

It can be seen that the CHIBOR sequence has strong autocorrelation, so the autocorrelation coefficient, partial correlation coefficient and Ljung-Box statistic Q-t of CHIBOR first order difference sequence are as follows:

It can be seen from the graph that the CHIBOR first order difference sequence has a weak autocorrelation phenomenon. Combining the above conclusion, we can know that the interbank lending market interest rate sequence is related, that is, the interbank interest rate is mutual influence.

5. Conditional heteroskedasticity test

The variance of financial time series variables is the most important parameter in the calculation of VaR. Most scholars calculate VaR, assuming that the variance is constant, that is, the unconditional distribution hypothesis. However, the financial variables are often different from the unconditional distribution assumptions. In order to accurately measure the volatility of financial time series, economists try to build various models, among which ARCH model and GARCH model are the most widely used, because the volatility of financial variables is often described by variance and standard deviation. A large number of predecessors have proved that the GRACH model is suitable for predicting the volatility of financial time series. So here I also use the GRACH model to estimate the volatility between China's interbank offered rates.



(Figure), we can see that the fluctuation has obvious time-varying nature, and the volatility of different periods of the size is not the same, while fluctuations in the phenomenon of aggregation, the volatility of the interbank lending rate, Thus, there is a conditional heteroskedasticity in the interbank interest rate sequence.

Here we analyze the relationship between the variance of each period, the timing chart shows the fluctuation of the aggregation of the adjacent volatility there is a certain correlation between. According to the approximate estimate, we can use the variance to test whether there is a correlation between the variance of each period.

The following figure shows the autocorrelation test of the square sequence of CHIBOR:

It can be seen that the square sequence of CHIBOR still has a strong autocorrelation with its lag order, and there is an autocorrelation phenomenon.

(3) Model establishment

By examining the normality, stability, autocorrelation and conditional heteroskedasticity of the interbank interest rate sequence. We can initially conclude that interbank interbank interest rate sequences exist autocorrelation, heteroskedasticity and other characteristics. The GARCH family model includes many models, among which the GARCH model, the EGARCH model and the TGARCH model are well known. These models are developed from ARCH models, and are suitable for estimating the time series of autoregressive conditional heteroskedasticity. To establish the model, we must first determine the order of the lag, respectively, the three models for the data, with Akashi information criterion AIC to determine the most lag order.

Interbank interest rate volatility model trial results

Hysteresis order	GARCH AIC	TARCH AIC	EGARCH AIC
(1,1)	-2.6411	-2.5075	-2.6498
(2,1)	-2.6309	-2.4880	-2.6106
(1,2)	-2.6125	-2.4034	-2.5845
(2,2)	-2.5797	-2.4422	-2.5981

Since the AIC criterion requires that the explanatory variable be added to the original model only if the added explanatory variable can reduce the AIC value. In the above results, the AIC value increases with the increase of the hysteresis order (TRACH and EARCH appear in (2, 2), but the amplitude is very small), taking into account the degree of freedom, select the GARCH group lag (1,1) model.

3. Empirical analysis and model test

In the case where the model hysteresis is determined above, we have to carry out empirical tests because we have used three models in the GARCH family model, which means that we also have three VaR estimates here.

On the basis of the definition of VaR, we use the formula VaR of interest rate fluctuation as follows:

$VaR_{(t+1)}=\omega_t (E(r)-r^*)=\omega_t \alpha_c \sigma_{(t+1)}$

Where $VaR_{(t+1)}$ the t is the expected value of the next day, the expected value of the interest rate, E(r), the lowest interest rate, $\alpha_c$the corresponding quantile at the given confidence level c, and $\sigma_{(t+1)}$ the volatility of the interbank interest rate on the next day predicted by the t period.

The value of the quantile depends on the probability distribution function of the interest rate. Under different probability distribution functions, there is a difference in the quantile corresponding to the same confidence level c. The standard deviation is divided into standard deviation and unconditional standard deviation. The unconditional standard deviation assumes that the interest rate fluctuation is always constant. The conditional standard deviation is a reflection of the inconsistency of interest rate fluctuation over time. It is a dynamic measure of interest rate risk and can be accurate to grasp the changes in risk. The calculation of VaR is mainly done by establishing a dynamic model for estimating the standard deviation of conditional criteria.

For the residual distribution in the GARCH family model, there are three general assumptions: normal distribution, student t distribution and generalized error distribution (GED). Choose which distribution to be based on the characteristics of the time series. Normal distribution is an important probability distribution, and the good statistical properties such as symmetry and easy addition of normal distribution determine its important role in financial analysis. Based on the analysis of the VaR of the interbank interest rate sequence in other distributions, the VaR of the loan interest rate sequence is calculated under the assumption of normal distribution as the basis for comparison.

A large number of financial empirical studies have shown that the distribution of market factors (such as price and interest rate) in the financial market has the characteristics of spikes and thick tails, which is quite different from the normal distribution. Through the normative test of the interbank interest rate sequence of China, the borrowing rate

sequence does not obey the normal distribution and has a thick tail. T distribution is a distribution with thicker tail than the normal distribution probability density function, which is suitable for the analysis of the distribution with thick tail characteristics. After calculating the VaR under the normal distribution, the t distribution is assumed to be used to calculate the inter- VaR of the Interbank Rate Sequence.

Generalized error distribution (GED) is a more flexible form of distribution, through the adjustment of the parameters can be adapted to different distribution situations. It is proposed by J.P.Morgan, and its probability density function can analyze both the tail than the normal distribution and t distribution thick case, you can also analyze the tail than the normal distribution of thin case.

When calculating the VaR by parametric method, it is assumed that the residuals of the model obey the normal distribution, t distribution and roll-error distribution. The following is the result of the calculation.

The EView software was used to analyze the volatility (standard deviation) of the GARCH model in the same distribution, and then the estimated value was taken into the VaR formula. The daily VaR of the interbank offered rate was calculated at 95% confidence level, Get the following table.

Model estimation results

Model	Parameter	Normal distribution	T - distribution	Generalized error distribution
GARCH(,1) model	ω(constant)	0.000378	0.000195	0.000197
		(9.4768)	(2.0794)	(2.0097)
	α(+ coefficient)	0.768224	0.479672	0.438659
		(17.9872)	(6.1157)	(6.136954)
	β (Coefficient)	0.608172	0.730903	0.809832
		(5.7843)	(24.8821)	(19.8425)
	Score)95%)	2.4679	2.7458	2.3964
	Daily average VaR)95%)	0.0067943P_t	0.0069801P_t	0.0055031P_t
TARCH(1-1) model	ω(constant)	0.000301	0.000209	0.000193
		(4.6793)	(1.8693)	(1.6493)
	α(+ coefficient)	0.841312	0.559931	0.463320
		(12.9783)	(5.0032)	(5.3248)
	γ(+ coefficient)	-0.637952	-0.569327	-0.173856
		(-6.5548)	(-1.7698)	(-1.5099)
	β (Coefficient)	0.647079	0.854671	-0.173856
		(35.994)	(24.3644)	(18.3291)
	Score(95%)	2.4591	2.8643	2.5068
	Daily average VaR)95%)	0.0061921P_t	0.7092304P_t	0.0064698P_t
EGARCH(1,1) model	ω(constant)	-0.983054	-0.973054	-0.649545
		(-12.0180)	(-12.9843)	(-6.4740)
	α(+ coefficient)	0.672970	0.684521	0.499100
		(14.8752)	(15.0081)	(5.9481)
	γ(+ coefficient)	0.297472	0.279451	0.178364
		(8.0949)	(8.8495)	(3.4215)
	β (Coefficient)	1.003430	1.035698	0.954678
		(70.9844)	(73.9151)	(60.5125)
	Score(95%)	2.6691	2.8161	2.4633
	Daily average VaR(95%)	0.0063571P_t	0.0074891P_t	0.0062871P_t

4. Conclusions

By analyzing the VaR model based on the GARCH (1, 1) family model, we can analyze the interest rate risk of the interbank market in China. Before the analysis, we can see through the basic descriptive statistics that the interbank interest rate fluctuation is Very violent, this side of the reason is the market-oriented reform of the deepening, deepening the market; the other hand, but also reflects the instability of the market. And we through the exact model can be drawn more data of the conclusions:

1. By comparing the GARCH (1, 1) model, TARCH (1, 1) model and EGARCH (1, 1) model of the estimation results, we can see that in fact the three types of models concluded that there is not much difference of. However, the VaR values calculated by the three models are larger than those of the normal distribution and the generalized error distribution. At the same time, the t-distribution is not suitable for describing the distribution of interbank lending rates in China, and the generalized error Distribution can be a good description of the distribution of interbank lending rates in China.

2. In the analysis of the second GARCH model TARCH (1, 1), we can see from the table, because the acquisition is not significant, indicating that China's interbank offered rate does not exist obvious leverage; and EGARCH (1, 1), the coefficient indicates that there is a leverage effect in the interbank offered rate and the bad news is more favorable than the good news. The difference between the two models shows whether there is a leverage effect is not clear.

3. The three GARCH models in the calculation of VaR value, almost all come to a similar VaR value, about 0.006 or so, indicating that in the data selection interval between the inter-bank interbank interest rate risk is low, about 0.6%.

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