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Empirical analysis of A -share market index yield series based on GARCH-M model

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Abstract

GARCH model is used in the analysis of financial time series widely, the model can simulate financial time series.The domestic implementation loosed monetary policy because of the domestic individual investors investment enthusiasm rising.Under the background large amounts capital surplus,this paper research A-share market index volatility characteristics through stationary, ARCH effect test, then it established GARCH, Garch-M, EGARCH dynamic time series model.The conclusion is Garch-M model has the best fitting effect for A-share market index yield.

Key words: Arch;Garch-M model;A-share

GARCH (generalized auto regressive conditional hetero scedasticity) model is used in financial, economic and other related fields of time series widely, the model can describe the methods of volatility, as many financial time series provides an effective analysis method it is by far the most common and most convenient heteroskedasticity sequence fitting model. On the basis of the ARCH model, the GARCH model is added to consider the auto correlation function of heteroscedasticity function, which can be used to fit the heteroscedasticity function with long-term memory.

1.Theory

ARCH model called auto regressive conditional heteroscedasticity model, residual high-frequency time series data has the characteristics of heteroscedasticity and auto correlation called ARCH effect, the principle is: a historical data can be obtained in case of zero mean and pure random residuals with heteroscedasticity.Its full expression is:

$$x_t = f(t, x_{t-1}, x_{t-2}, \cdots) + \varepsilon_t \qquad (1.1)$$

$$\varepsilon_t / \sqrt{h_t} \sim N(0,1) \qquad (1.2)$$

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$$h_t = E(\varepsilon_t^2) = \omega + \sum_{j=1}^{q} \lambda_j \varepsilon_{t-j}^2 \qquad (1.3)$$

ARCH model used square error sequence moving average fitting current variance function value, while moving average model with self censoring Q order correlation coefficient, thus defining time ARCH model for variance function, only in the short term can be effective. If we want to solve the long-term autocorrelation between residuals, we use the GARCH model to fit the serise as follows:

$$x_t = f(t, x_{t-1}, x_{t-2}, \cdots) + \varepsilon_t \qquad (1.1)$$

$$\varepsilon_t / \sqrt{h_t} \sim N(0,1) \qquad (1.2)$$

$$h_t = E(\varepsilon_t^2) = \omega + \sum_{j=1}^{q} \lambda_j \varepsilon_{t-j}^2 + \sum_{i=1}^{p} \eta_i h_{t-i} \qquad (1.3)$$

Where p≥1,q>0, λ_j, η_i are larger than zero, $\varepsilon_t = (\omega, \eta_1, \cdots \eta_p, \lambda_1 \cdots \lambda_q)$ .For the auto regressive model, this model called GARCH (p, q).Under the condition of strict stability, $\sum_{i=1}^{p} \eta_i + \sum_{j=1}^{q} \lambda_j \prec 1$ has a unique stable solution.

2.Empirical analysis

(1)The ARCH effect test results of A-share market index yield series:

Heteroskedasticity Test: ARCH

F-statistic	11.26710	Prob. F(8,1183)	0.0000
Obs*R-squared	84.39241	Prob. Chi-Square(8)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/03/14 Time: 15:54
Sample (adjusted): 9 1200
Included observations: 1192 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	9.89E-05	1.61E-05	6.137660	0.0000
RESID^2(-1)	-0.005116	0.029010	-0.176362	0.8600
RESID^2(-2)	0.076696	0.028702	2.672171	0.0076
RESID^2(-3)	0.139247	0.028596	4.869495	0.0000
RESID^2(-4)	0.016088	0.028873	0.557203	0.5775
RESID^2(-5)	-0.016513	0.028872	-0.571924	0.5675
RESID^2(-6)	0.108216	0.028589	3.785283	0.0002
RESID^2(-7)	0.142784	0.028652	4.983369	0.0000
RESID^2(-8)	0.016620	0.028919	0.574721	0.5656

R-squared	0.070799	Mean dependent var	0.000191
Adjusted R-squared	0.064515	S.D. dependent var	0.000387
S.E. of regression	0.000374	Akaike info criterion	-12.93563
Sum squared resid	0.000166	Schwarz criterion	-12.89725
Log likelihood	7718.637	Hannan-Quinn criter.	-12.92117
F-statistic	11.26710	Durbin-Watson stat	1.997362
Prob(F-statistic)	0.000000		

Figure1 ARCH effect test

LM test determines whether the existence of the ARCH effect according the output F statistics or square statistics. From the above results, we can conclude that the probability P value of the F statistics and χ^2 square statistics are less than χ^2 0.05, so the AG yield sequence has significant ARCH effect, which is consistent with the conclusion of the graphical test. The results show that the AG

sequence has the conditional heteroscedasticity, so it is necessary to use the conditional heteroskedasticity model, GARCH model can fit the volatility of A stock returns.

This part established GARCH (1,1) model, GARCH-M(1,1) model,EGARCH(1,1) model for A-share yield series.

Table 1 GARCH model

Model	Mean equation	P Value	Variance equation	P Value
Symmetric GARCH	$ag_t = -0.00010 + \varepsilon_t$	0.7851	$\sigma_t^2 = 0.0000252 + 0.0256\varepsilon_{t-1}^2 + 0.9588\sigma_{t-1}^2$	0.0040 0.0000 0.0000
symmetric GARCH-M	$ag_t = -0.002613 + \varepsilon_t$	0.0104	$\sigma_t^2 = 0.0000252 + 0.0256\varepsilon_{t-1}^2 + 0.9588\sigma_{t-1}^2$	0.0040 0.0000 0.0000
Asymmetric GARCH	$ag_t = -0.000105 + \varepsilon_t$	0.7754	$In\sigma_t^2 = -0.1782 + 0.0741\frac{\lvert\varepsilon_{t-1}^2\rvert}{\sigma_t} - 0.01598\frac{\varepsilon_{t-1}^2}{\sigma_t} + 0.986In\sigma_{t-1}^2$	0.0008 0.0000 0.232 0.0000

The above analysis results are compared to test the better model, as shown in table 2:

Table 2 GARCH model parameter comparison table

	Log likelihood	Akaike info criterion	Schwarz criterion	P值（显著性）
GARCH	3480.986	-5.795	-5.789	0.7851
GARCH-	3484.380	-5.779	-5.778	0.0104
EGARCH	3481.604	-5.794	-5.773	0.7754

The symmetric GARCH model and asymmetric GARCH model to fit AG returns from the above parameters, test comparison of the three models, the GARCH-M model was the mean equation is relatively better, the Akaike info criterion and Schwarz criterion value was not significantly better than the other two models, but compare with the overall model is superior to the conventional GARCH and EGARCH model therefore, using the GARCH-M model of A-share market index yield model is appropriate.

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