Econometric modelling of volatility of securities traded on the Macedonian Stock Exchange

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1. The GARCH (1,1) model

Volatility has always been a key element in investment decisions and modeling of financial markets. Shiller (1989), Turner and Weigel (1990), Scott (1991) and Peters (1994) have recently investigated financial market volatility, among others. However, resources, in general, seem to have been devoted to studies concerning developed financial markets. This paper attempts to investigate stock market volatility in an emerging market of a country in transition, namely Macedonia.

In order to perform quantitative analysis of time series and determine the future trend of prices and volatility, it is necessary to establish appropriate econometric models. The development of econometrics led to the invention of adaptive methods for modeling the mean value of the variable in question, the mostly widely used of which are the ARIMA methods (Box and Jenkins 1970). In this paper I will show how the GARCH (1,1) model can be used for forecasting of securities volatility.

The model is based on the assumption that forecasts of variance changing in time depend on the lagged variance of capital assets. A general GARCH model is given by the following equation:

$$\sigma_{t+1}^2 = \omega + \beta\sigma^2 + \alpha\eta_t^2 \qquad 0 \le \alpha, \beta, (\alpha + \beta) \le 1 \qquad (1)$$

The importance of some parameters becomes clearer if we rewrite the relation (6) in a different way:

$$\sigma_{t+1}^2 = \omega + (\alpha + \beta)\sigma_t^2 + \alpha(\eta_t^2 - \sigma_t^2) \qquad (2)$$

The term $(\eta_t^2 - \sigma_t^2)$ represents shock to the volatility series, while the parameter α determines how strong this shock affects the future volatility. The reciprocal value of the sum of parameters $\alpha + \beta$ shows the rate at which the effect dissipates in time. It can be shown that based on information at the moment *t* we can estimate volatility after *n* periods ahead by means of the following relation:

$$E_t\left[\sigma_{t+n}^2\right] = (\alpha + \beta)^n + (\sigma_t^2 - V) + V \qquad (4)$$

where *V* is unconditional volatility estimation.

It should be noted at this point that the same equations could be used for modeling of correlation between time series, which is very important issue in portfolio management.

2. Empirical estimation of parameters in the GARCH (1,1) model

We will show how we can estimate parameters α, β and ϖ for a specified time series. For that purpose we can use the method of maximum probability given by the expression:

$$L = \sum_{i=1}^{T} \left[-\ln\sqrt{2\pi} - \frac{1}{2}\frac{\eta_i^2}{\sigma_i^2(\alpha,\beta,\varpi)} - \frac{1}{2}\ln\sigma_i^2(\alpha,\beta,\varpi) \right] \qquad (5)$$

Table 1: Calculation of parameters in the GASRCG (1,1) model

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It can be seen from the Table 1 that the parameter α is extremely high showing that the volatility depends very much on innovation in the previous time period. The sum of parameters $\alpha + \beta$ for MBI is close to 1, showing the effects of long memory in the series.

With regard to short-term risk forecasting, this method could significantly improve the short-term risk forecasting in the case of Alkaloid shares. However, for those time series where $\alpha + \beta$ is closer to 1, as is the case with MBI, the GARCH (1,1) model can be used for much longer time segments cautiously.

REFERENCES

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RÉSUMÉ

On a prouvé avec ce travail qu'on peut utiliser le modèle GARCH/1,1/ pour prévoir la volatilité des papiers – valeur. Etant donne, on a calculé des paramètres pour quelques papiers-valeur caracteristiques commercant sur la Bourse macedonienne des papiers-valeur. On a prouvé aussi des resultats pratiques obtenus avec ce modèle par rapport de la prevision des risques à court-terme. Pour prévoir la volatilité journalière et pour la période de dix jours en avant, GARCH(1.1) modèle ne donne pas des bonifications. Etant donné, il est necessaire de modeler la covariabilité de certains papiers-valeur dans le cadre de la portefeuile.