Alina Kravchenko
First-year Master student,
Taras Shevchenko National University,
Kyiv, Ukraine
linaakravchenko@knu.ua

ESTIMATING CRYPTOCURRENCIES' VOLATILITY BY GARCH SPECIFICATIONS

Introduction. Due to the active globalization, which includes computerization and development of IT technologies, the modern financial systems of the countries show dynamic development. This creates new institutions and industries, in particular, alternatives to common methods of payment - cryptocurrencies. This product contributes to the rapid development of the financial sector and also enables ordinary citizens and investors to raise their capital. Because of its volatility and the significant difference between the lower and upper thresholds in the financial market and stock exchanges, cryptocurrency is one of the most profitable trading tools. That is why the modeling and forecasting of cryptocurrency prices is a very relevant topic today.

The purpose of this research is to evaluate the volatility of 5 digital coins and to identify the models of hetoskedastic processes that best characterize the behavior of the three most powerful cryptocurrencies of today.

Literature overview. Due to the increasing interest in cryptocurrencies and the fact that they are highly volatile, there is a need to quantify their variance. Previous studies that have been carried out with regard to the study of cryptocurrencies' volatility have implemented a variety of GARCH models, such as Linear GARCH, Threshold GARCH, Exponential GARCH and Multiple Threshold-GARCH. Bouoiyour and Selmi (2015) studied the price of Bitcoin, using a sample of daily data from December 2010 until June 2015. Their optimal model was the GARCH and showed that the volatility was significantly reduced, nevertheless this market was not mature, as there was asymmetry. Gronwald (2014) compared the gold and bitcoin market and analyzed bitcoin's prices using GARCH models. His main conclusion was that there were extremely large changes in its price and that the market it was trading on was not mature. In the same vein, Dyhrberg (2016b) using GARCH models examined Bitcoin's potentials as a financial product. The results showed that it had similarities with the gold and the US dollar. The asymmetric GARCH model provided evidences that this product could be used in portfolio management, as it was ideal for risk-averters investors.

Bouri et al. (2017) used asymmetric GARCH models in order to investigate the correlation between prices and volatility changes in the Bitcoin market around the bearish market in 2013. The results for the whole period did not provided any indication of an asymmetric relationship between yields and volatility in the Bitcoin market. In addition, positive shocks had increased conditional volatility more than negative shocks.Chu et al. (2017) in order to enrich the literature, they investigated which GARCH models are suitably adapted to Bitcoin, Dash, Dogecoin, Litecoin, Maidsafecoin, Monero and Ripple. They demonstrated that the IGARCH and GJRGARCH models provided the optimal solutions for modeling the volatility of the most popular cryptocurrencies on their blooming days. Finally, Beneki et al. (2019) relied on Bitcoin and Ethereum and they examined with BEKK-GARCH model, if there were differences in volatility and hedging abilities. Their results revealed significant swaps in the time-varying correlation, as well as certain diversification skills especially in the early years of their study.

Results. The main problem in analyzing and forecasting financial asset prices is related to risk assessment. Time series of returns and their volatility have a number of specific features, including: no autocorrelation, volatility clustering, leverage effect, etc. In research was used ARCH / GARCH methodology, that describes similar time series behaviors, and their modifications - Nelson's EGARCH, Threshold GARCH, GJR Form of Threshold GARCH, Simple asymmetric GARCH, Power GARCH, Nonlinear GARCH, Asymmetric Power GARCH and Nonlinear GARCH.

For the study were used daily closing prices of 8 cryptocurrencies: BTC, ETH, XRP, LTC, BNB, DOGE, ZEC and NANO. For more accurate and qualitative results, yields were used as variables - logarithmic first-order price differences for cryptocurrencies.
For each cryptocurrency descriptive statistics were calculated and analyzed. As a result, almost all cryptocurrencies have negative average reeturns with the lowest in ZEC and highest in BNB. The coin with the least standard deviation, and therefore with the least volatility, is BTC. The most standard deviation, respectively, and the most risky cryptocurrency was Nano. As for the asymmetry coefficient, 2 out of 8

cryptocurrencies have negative asymmetry, which is not positive for investors. The excess rate is quite high for all cryptocurrencies, which indicates the presence of heavy tails.

In order to investigate the volatility and relationship between cryptocurrencies, the time series of cryptocurrencies were checked for ARCH / GARCH effect. For this purpose, the residuals of each time series obtained from a simple regression model using the ARCH LM test were tested. After that, different models of the ARCH and GARCH family were built for each of the 5 cryptocurrencies. Similar models were constructed, assuming that the residuals have not a normal distribution but a Student distribution, since this distribution has a large courtesy at small degrees of freedom. The most appropriate model for each currency was selected using the AIC and BIC criteria.
So, for LTC, the best model, based on the AIC and BIC information criteria, is the Student's Nonlinear Power GARCH. This means that the relationship between the variables considered is non-linear, which determines the threshold at which LTC yields will respond differently to Bitcoin, Ethereum, and Ripple. All three independent variables are significant at each level of statistical significance and positively related to LTC.

For the BNB, based on the values of both the AIC and BIC information criteria, there is an EGACH model with Student`s distribution. The EGARCH model takes into account the asymmetric impact of news on future volatility, and the simulation concludes that "bad" and "good" news asymmetrically affect on conditional variance. All 3 cryptocurrencies are positively related to BNB, but only BTC and ETH are statistically significant coefficients.
For Doge Coin, the A-GARCH model is the best model for both AIC and BIC. This model allows us to take into account the asymmetric impact of the "bad" and "good" news and provides the so-called "leverage" effect. The asymmetry coefficient in the model is less than zero, which means that there is a "leverage effect". Consequently, positive shocks lead to a smaller increase in Doge Coin volatility compared to negative shocks.

The best model for Zcash modeling is the simple GARCH model with Student’s distribution. This means that there is no leverage effect and asymmetric effects. All three cryptocurrencies are positively related to Zcash and are statistically significant at each level of statistical significance.

According to the results of both information criteria, the best model for Nano is the asymmetric EGARCH model with Student's distribution and since the asymmetry coefficient is not 0, there is an asymmetric effect of "good" and "bad" news. All three cryptocurrencies are positively related to Nano, but only BTC and XRP are significant.

Conclusions. This research investigates how some of the highest capitalization cryptocurrencies are related to the three principal ones and the direction and size by which their performance is affected. In order to select the most appropriate model among the many models that were implemented, the Akaike Information and Bayesian Schwartz criteria were used. In the result of this research, there is no single best model for all cryptocurrencies. For all cryptocurrencies the assumption of classic GARCH model, that residuals follow normal distribution, wasn`t confirmed. The best models were obtained using the fact that the residuals follow Student's distribution.

Finally, this study could provide avenues for further research in complementarity or substitutability among cryptocurrencies and how this could impact the risk-return trade-off in digital currency portfolios.

References

1. Lorenzo Cappiello. Asymmetric Dynamics in the Correlations Of Global Equity and Bond Returns, The Journal of Finance, no. 46, pp. 1839– 1885, 1991
2. Jamal B. Modeling exchange volatility in Egypt using GARCH models, MPRA Paper, no. 49, pp. 1–26, 2013
3. Bülent Köksal. A Comparison of Conditional Volatility Estimators for the ISE National 100 Index Returns, Journal of Economic and Social Research no. 11, pp. 1-28, 2013
4. Cristina PETRICĂ. Empirical Results of Modeling EUR/RON Exchange Rate using ARCH, GARCH, EGARCH, TARCH and PARCH models, Romanian Statistical Review, no. 1, pp. 57–72, 2017
5. Sharaf Obaid Ali. Estimating Stock Returns Volatility of Khartoum Stock Exchange through GARCH Models / Sharaf Obaid Ali, Abdalla Suliman Mhmoud. // Journal of American Science, no. 9, pp. 132–144, 2013