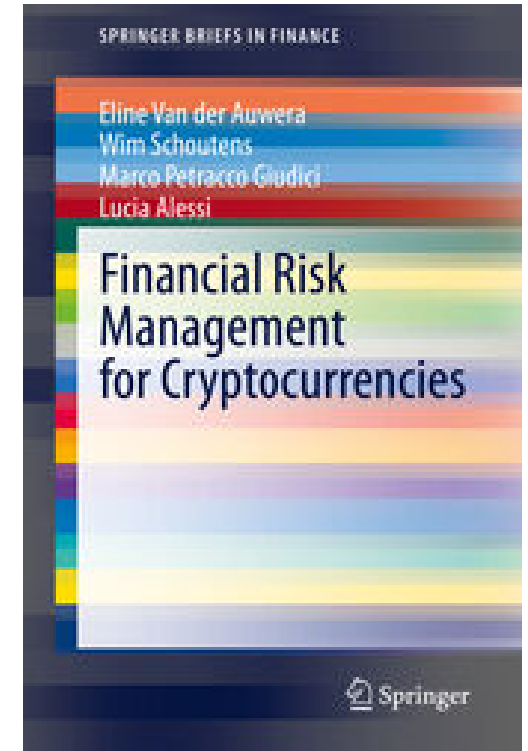


Financial Risk Management for Cryptocurrencies



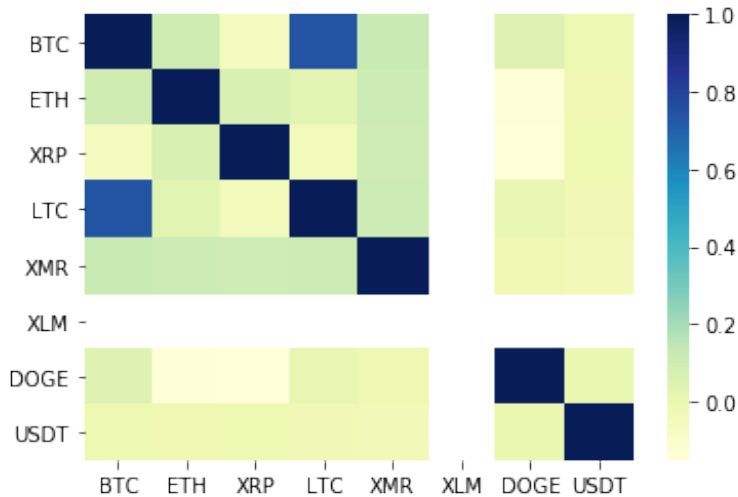
A QUANTITATIVE ANALYSIS

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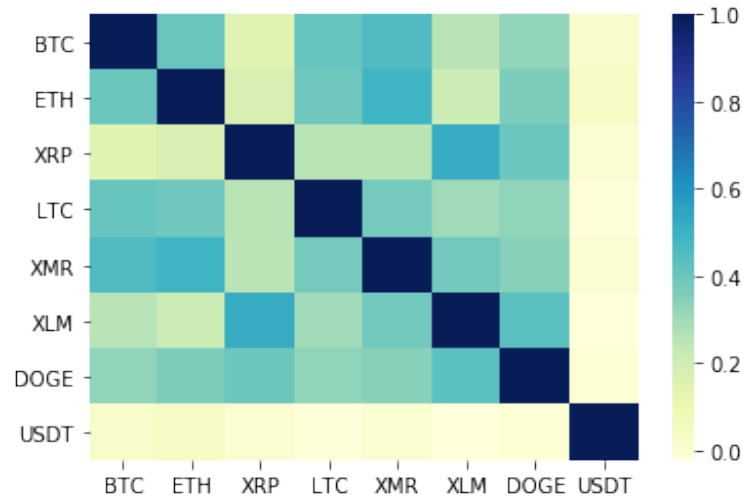
Introduction

- Correlation between cryptocurrencies and other asset classes
- Distributional properties
- Volatile behaviour
 - ARMA-GARCH
- Conclusion

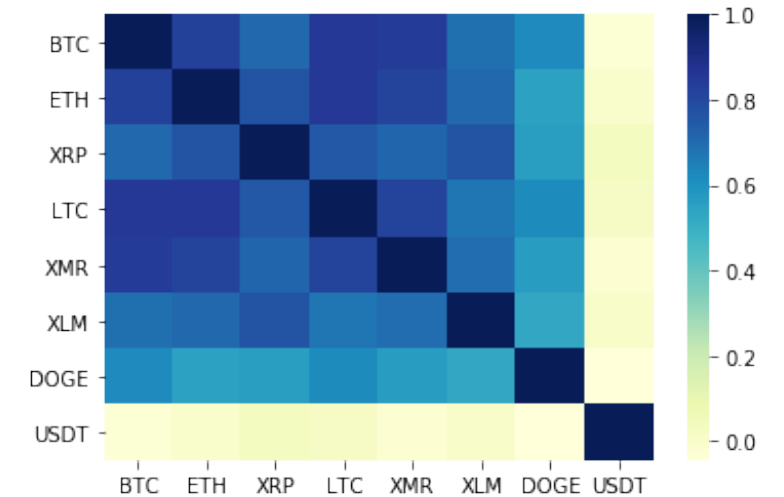
Correlation



2016



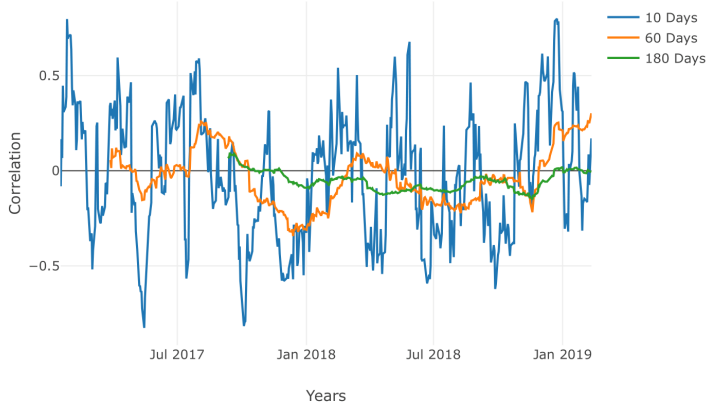
2017



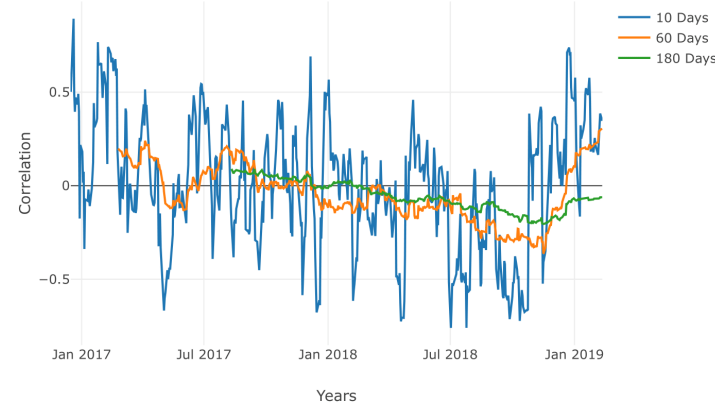
2018

- The cryptocurrency market becomes more correlated over time
- In the beginning only coins with similar characteristics, like Bitcoin (BTC) and Litecoin (LTC) were correlated
- Many cryptocurrencies are bought using Ether and Bitcoin

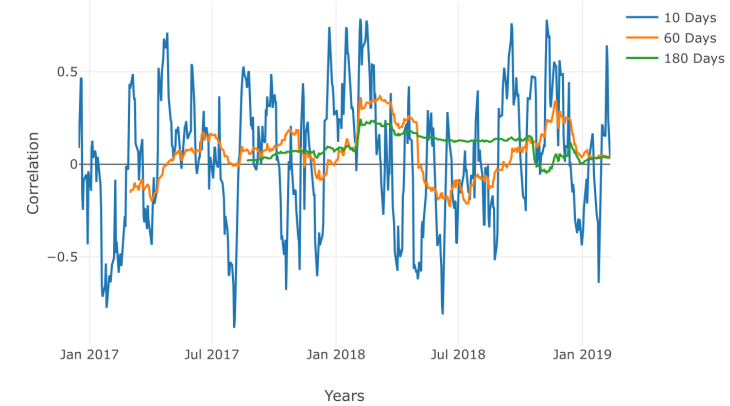
Correlation



EUR-USD XR - BTC



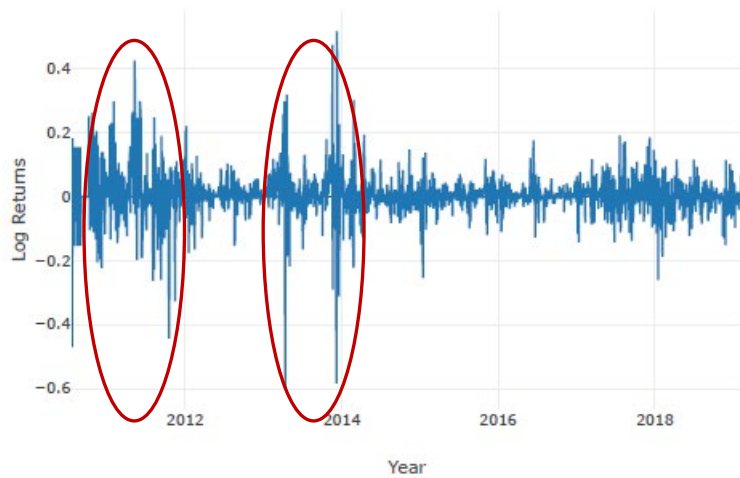
Gold-BTC



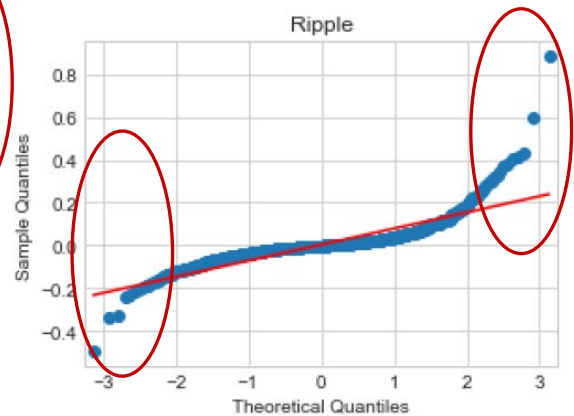
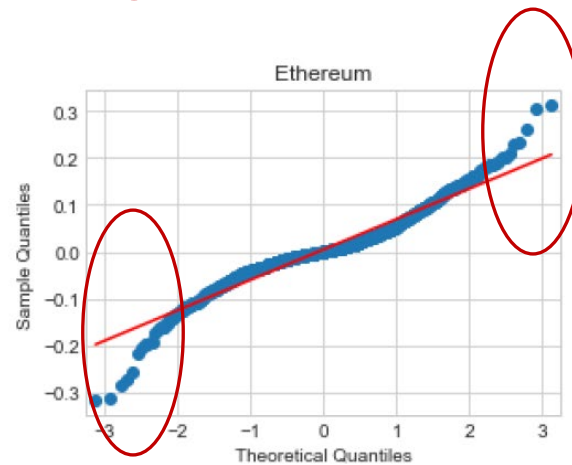
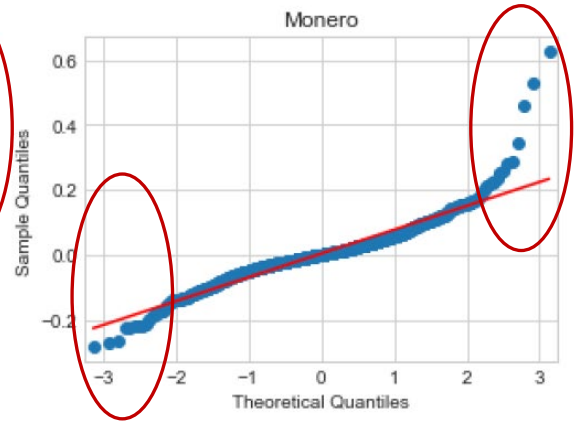
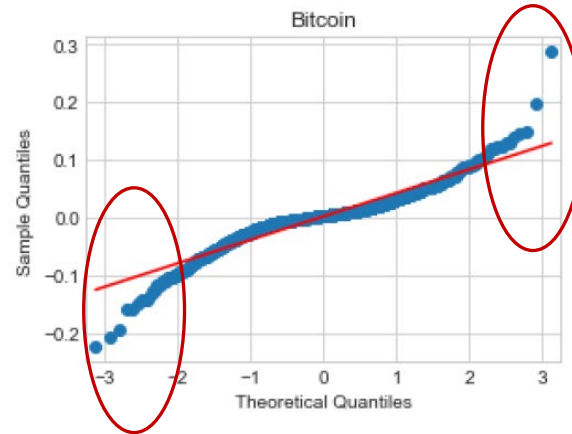
S&P500 - BTC

- 10-day correlation fluctuates around zero
 - 180-day correlation never exceeds 30% in absolute value
- > Differentiated risk reducer

Distributional properties

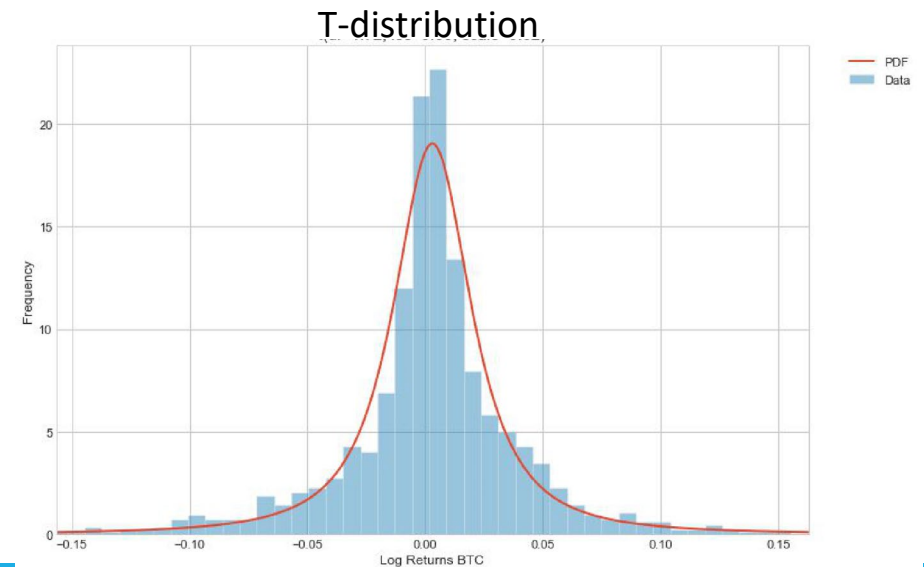
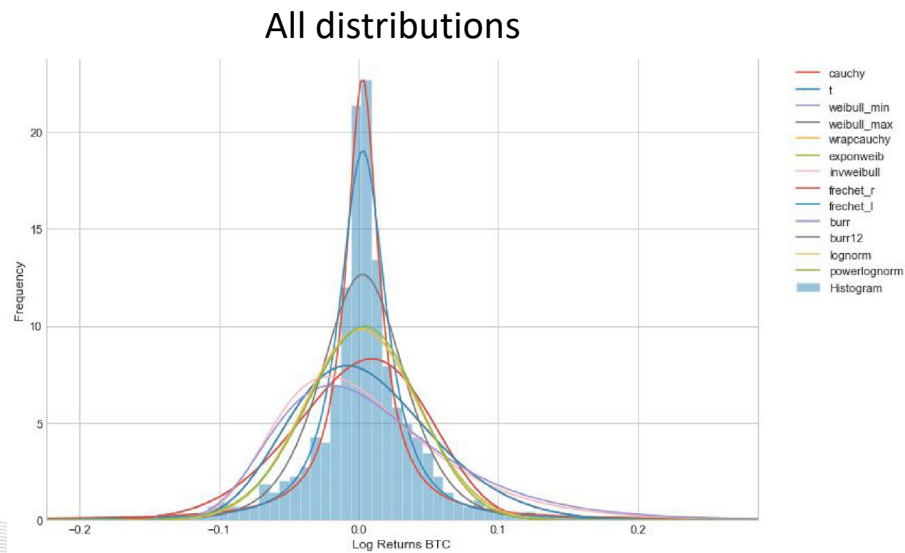


- Periods of high returns and low returns cluster together
- Fat tails



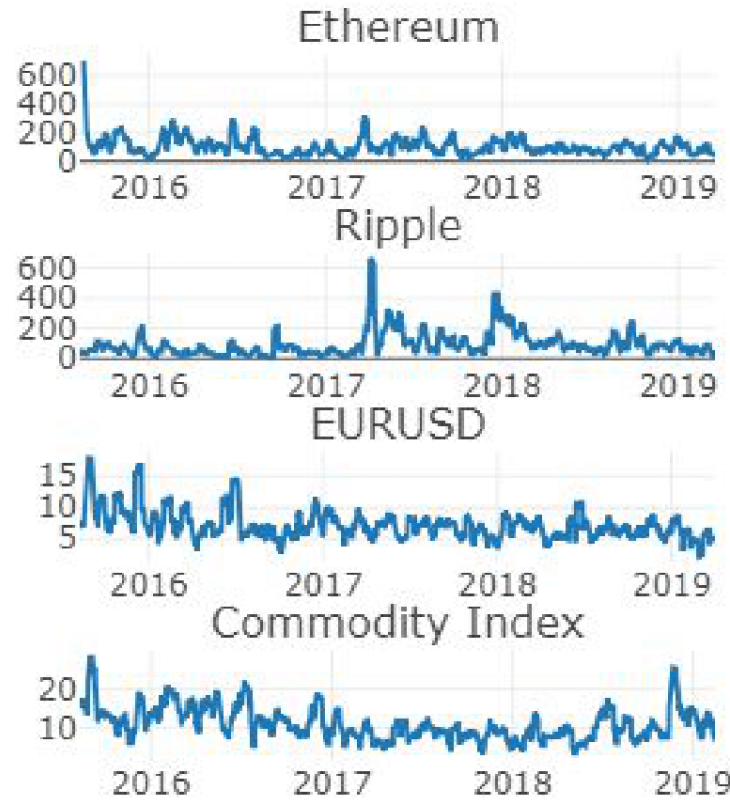
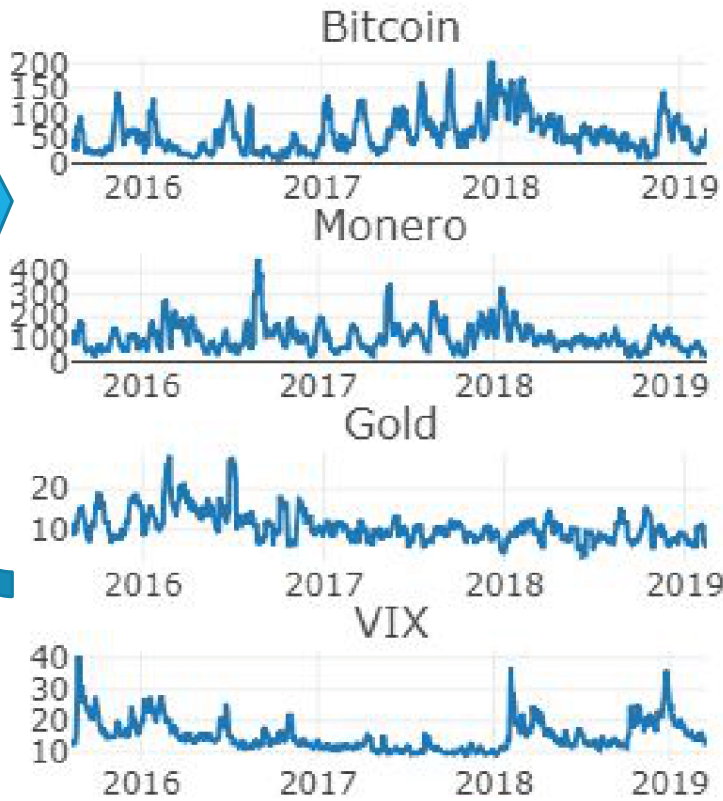
Distributional properties

- Excess kurtosis
- Which standardised distribution fits best?
 - Maximum likelihood estimation for the best fitting parameters
 - KS-test statistic to determine the goodness-of-fit



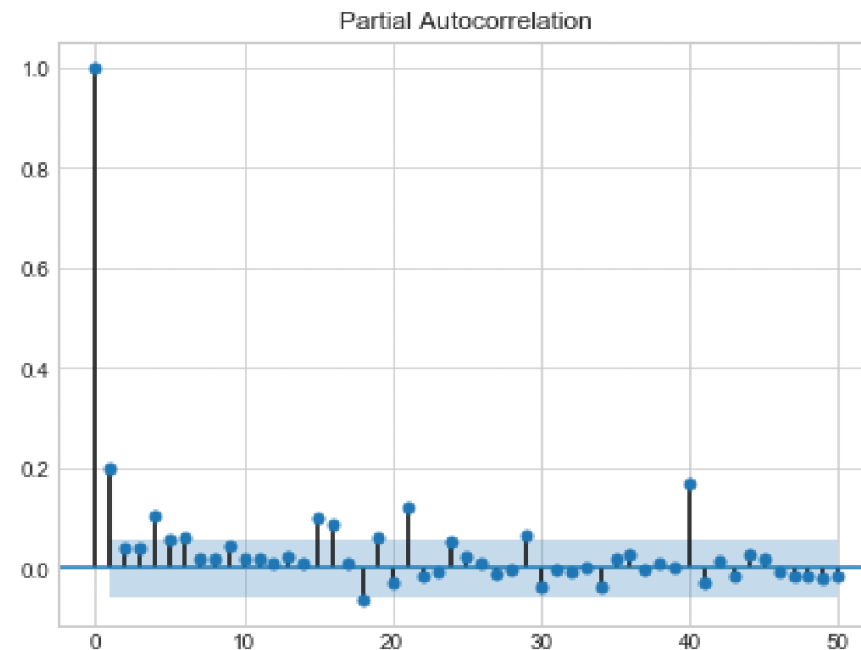
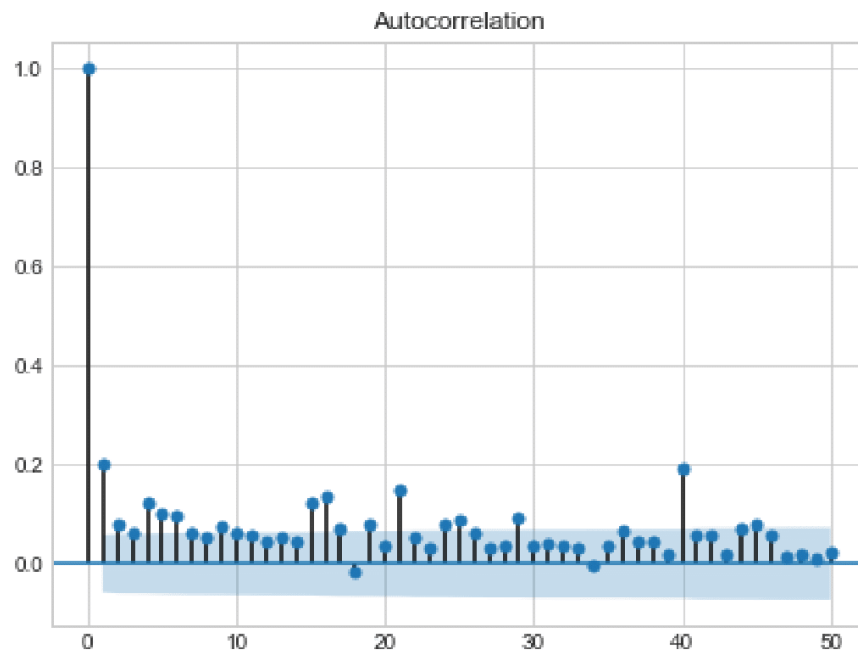
Volatile behaviour

- Extremely volatile
- Volatility clustering



ARMA-GARCH

- Returns are anti-persistent (fluctuate heavily + mean reverting) according to Hurst parameter
 - Returns exhibit autocorrelation
- > AR, MA and GARCH part are needed to accurately model the returns

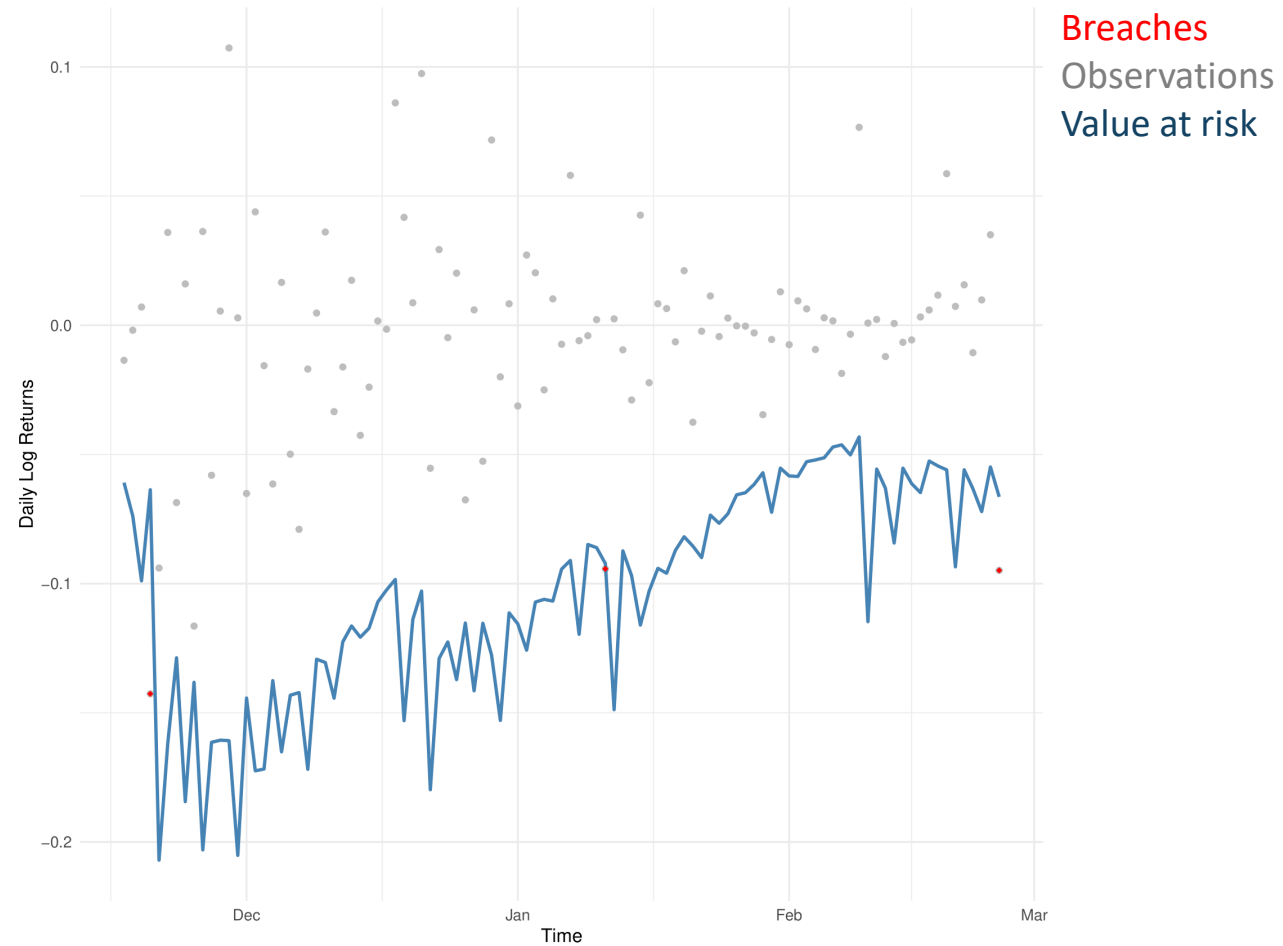


ARMA(2,2)-GARCH(1,3)

| | Coef. | Std. Err. | T-value | P-value |
|------------|------------|-----------|----------|--------------|
| c | 0.217 | 0.056 | 3.84794 | 0.000 |
| AR | ϕ_1 | 0.003 | -1.525 | 0.127 |
| | ϕ_2 | 0.003 | -329.674 | <u>0.000</u> |
| MA | θ_1 | 0.003 | -0.368 | 0.713 |
| | θ_2 | 0.000 | 5118.236 | <u>0.000</u> |
| ω | 0.225 | 0.113 | 1.989 | 0.047 |
| γ_1 | 0.267 | 0.042 | 6.309 | <u>0.000</u> |
| ψ_1 | 0.123 | 0.108 | 1.142 | 0.254 |
| ψ_2 | 0.193 | 0.098 | 1.961 | <u>0.049</u> |
| ψ_3 | 0.416 | 0.097 | 4.301 | <u>0.000</u> |
| ν | 3.340 | 0.259 | 12.884 | 0.000 |

- Ljung-Box test cannot be rejected
 - No autocorrelation left
- Arch LM test cannot be rejected
 - No arch effect left

ARMA-GARCH for VaR prediction



Conclusion

- The market is extremely inter-correlated and Bitcoin has the first mover advantage
- Differentiated risk reducer
- Cryptocurrencies have fat tails and high kurtosis -> t-distribution
- Volatility clustering and mean-reverting behaviour -> anti-persistent
- An ARMA(2,2)-GARCH(1,3) model is the best fitting model to the log returns of Bitcoin
 - It allows for an accurate VaR prediction