MUNI
ECON

Applied Financial Econometrics

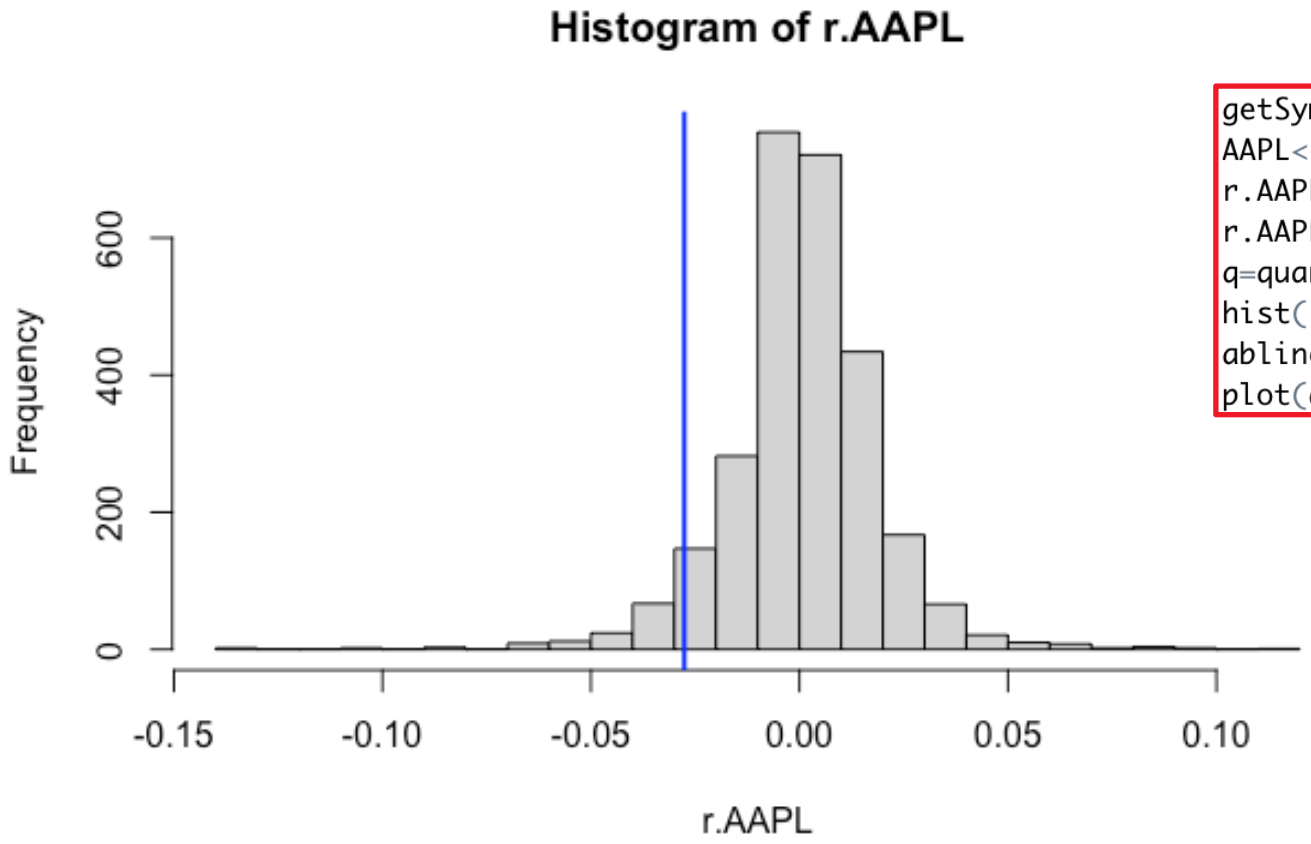
Class 7: Value at Risk (VaR)

Lecturer: Axel A. Araneda, Ph.D.

Risk measures: Value at Risk (VaR)

- Probability of (potential) losses given some probability.
- Downside risk based on current levels and normal market conditions.
- For a computed *T*-horizon *p*-VaR, a loss (*L*) will not exceed p-VaR with *p* probability *T*-periods ahead. *Prob(L>*VaR*) ≤1-p.*
- Example: One-day 95% VaR of 100.
  - 5% of losses falls over 100.
  - Expected losses greater than 100 for 1 day over 20 days.
  - 95% of confidence of don't have losses greater than 100.

Computing VaR




```
getSymbols('AAPL',src='yahoo', from="2012-01-01",periodicity = 'daily')
AAPL<-AAPL[,6]
r.AAPL<-diff(log(AAPL))
r.AAPL<-r.AAPL[2:length(AAPL)]
q=quantile(r.AAPL,0.05)
hist(r.AAPL,breaks = 20)
abline(v=q,col="blue",lwd=2)
plot(density(r.AAPL))
```

```
> quantile(r.AAPL,0.05)
          5%
-0.02761346
```

- 1-day 95% VaR: 2.76 %

MUNI ECON

Estimating VaR (in-sample)

- Assuming normality:

$$VaR(a) = \bar{x} + \sigma * N^{-1}(1-a)$$

$$VaR(95) = \bar{x} - \sigma * 1.644854$$

Example

– Estimating 97.5-VaR for AAPL, assuming the asset follows an ARMA(0,0) process; i.e., constant drift plus constant volatility, with normal disturbances.

$$r.AAPL_t = \mu + \sigma * \epsilon_t$$

$$\epsilon_t \sim N(0,1)$$

$$VaR(97.5) = \mu - \sigma * 1.96$$

Example: 97.5-VaR for AAPL

```
#Downloading data
#library('quantmod')
getSymbols('AAPL',src='yahoo',
      from="2015-01-01",periodicity = 'daily')

#log-returns
r.AAPL<-diff(log(AAPL[,6]))
r.AAPL<-r.AAPL[2:length(r.AAPL)]
# or equivalently:
#r.APPL<-na.omit(r.AAPL)
```

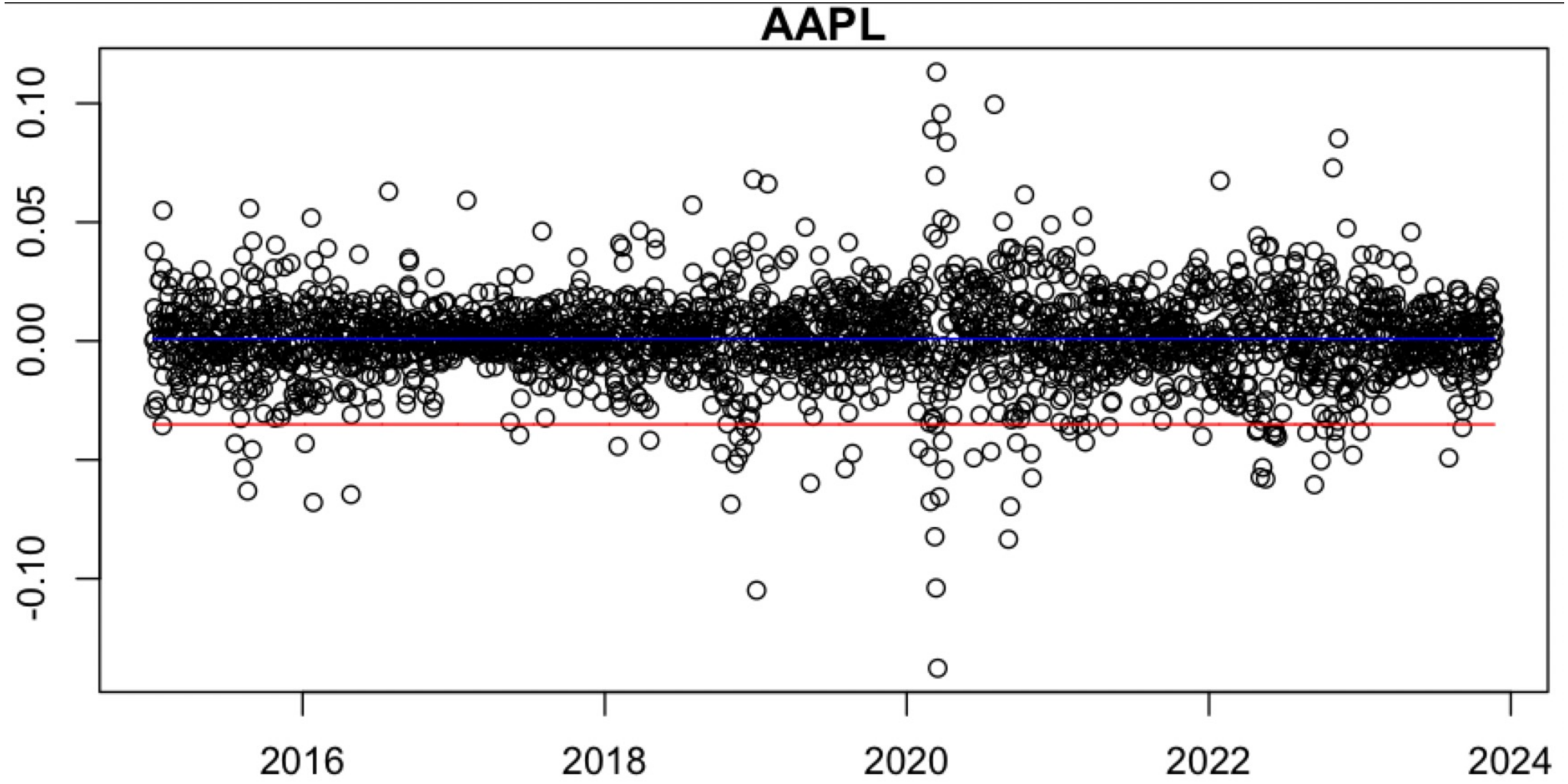
```
### The model #####
arima0<-arima(r.AAPL,order=c(0,0,0))
mu<-arima0$coef
sigma<-sqrt(arima0$sigma2)
## or equivalently
#mu<mean(r.AAPL)
#sigma<-sqrt(var(r.AAPL))
```

```
# 97.5-VAR under normality
VaR_AAPL<-mu-1.96*sigma
```

```
par(mfrow=c(2,1),mar=c(2.5,2.5,1,1))
plot(time(r.AAPL),r.AAPL,title('AAPL'))
lines(time(r.AAPL),rep(mu,
      length(r.AAPL)),col="blue")
lines(time(r.AAPL),rep(VaR_AAPL,
      length(r.AAPL)),col="red")
```

```
VaR_AAPL: 0.03510028
```

Example: 97.5-VaR for AAPL



MUNI ECON

Assignment

1. For the S&P500 and another asset of your choice, estimate the in-sample 1-day 95%VaR assuming normality and:
   a) Constant volatility and ARIMA(0,0,0) for the returns
   b) Constant volatility, finding the best ARIMA model possible for the returns, if any (auto.arima)
   c) GARCH(1,1) volatility.

2. Compare the results.