Homework #4

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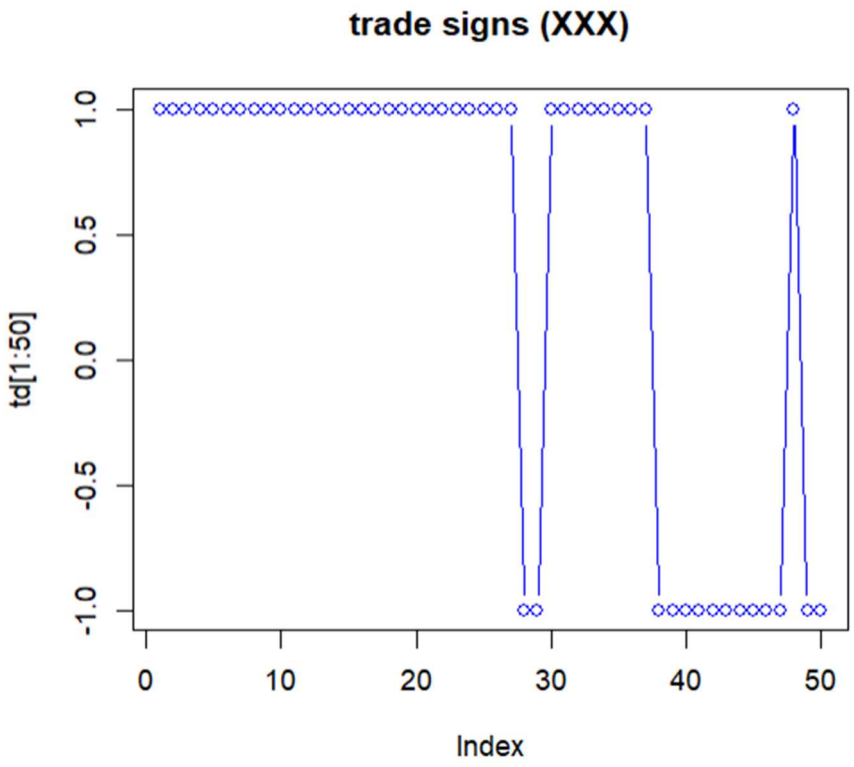
Glosten-Milgrom Model

The price process (p_t), follows the following equation where d_t is the trade direction and x_t is the signed trade size. Also, m_t is the mid-price and u_t is a random normal variable $\sim N(0, \sigma_u^2)$.

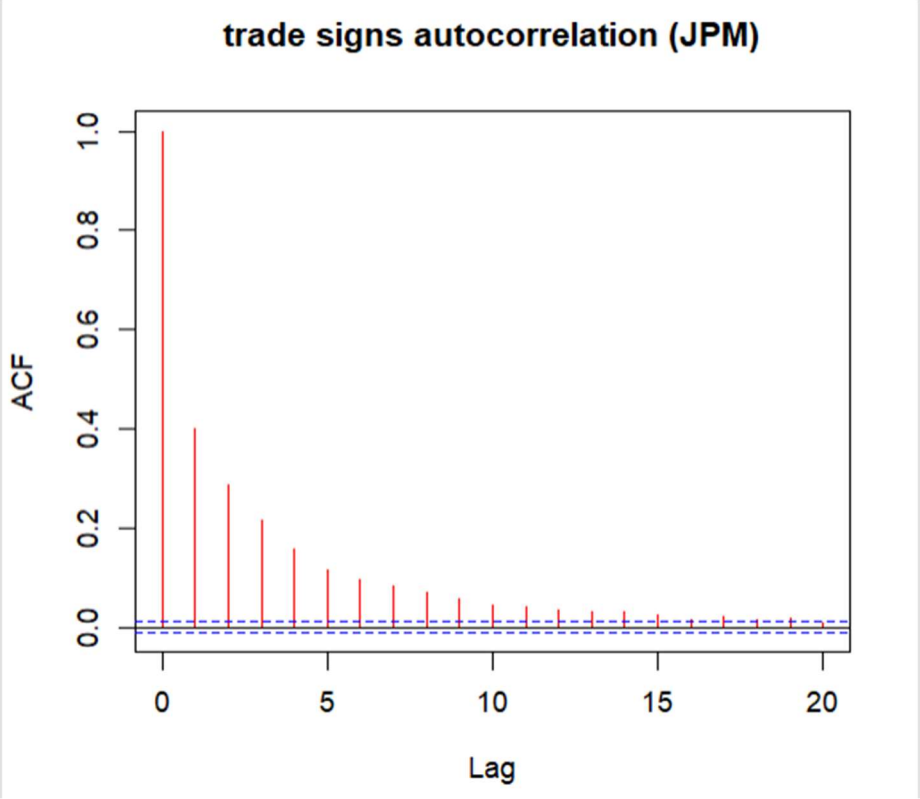
$$p_t = m_t + cd_t + \lambda x_t$$

$$\Delta m_t = \lambda x_t + u_t$$

1) First, we find the trade signs using Lee-Ready and store in variable d_t.



Also, there is considerable autocorrelation in the trade signs as shown by this ACF chart.



2) Now, we run a linear regression to determine λ.

```
mids <- (as.numeric(tqdata$OFR) + as.numeric(tqdata$BID))/2
dm <- diff(mids)
xt = as.numeric(tqdata$SIZE) * td
xt = xt[-length(xt)]
fit.lm = lm(dm ~ xt)
```

$$\Delta m_t = 5.057313 \times 10^{-8} x_t - 9.695411 \times 10^{-5}$$

$$\boldsymbol{\lambda = 5.057313 \times 10^{-8}, E(u_t) = 9.695411 \times 10^{-5}}$$

3) Finally, we need to determine c, which can be done by rearranging the first equation above and running another regression.

$$p_t - m_t - \lambda x_t = c d_t$$

```
##############################################
# determine c

rhs = pr - mids - lambda*xt # right hands side
fit.lm2 = lm(rhs ~ td)
summary(fit.lm2)
c = fit.lm2$coefficients[2]
```

$$p_t - m_t - \lambda x_t = \mathbf{0.02428612}\ d_t$$

$$\boldsymbol{c = 0.02428612}$$

In summary, $\lambda = \mathbf{5.057313 \times 10^{-8}}$ and $\boldsymbol{c = 0.02428612}$ **.** The constants λ and c give the magnitude of market impact and autocorrelation factor of trade direction signs respectively.