EC 513 Problem Set 1
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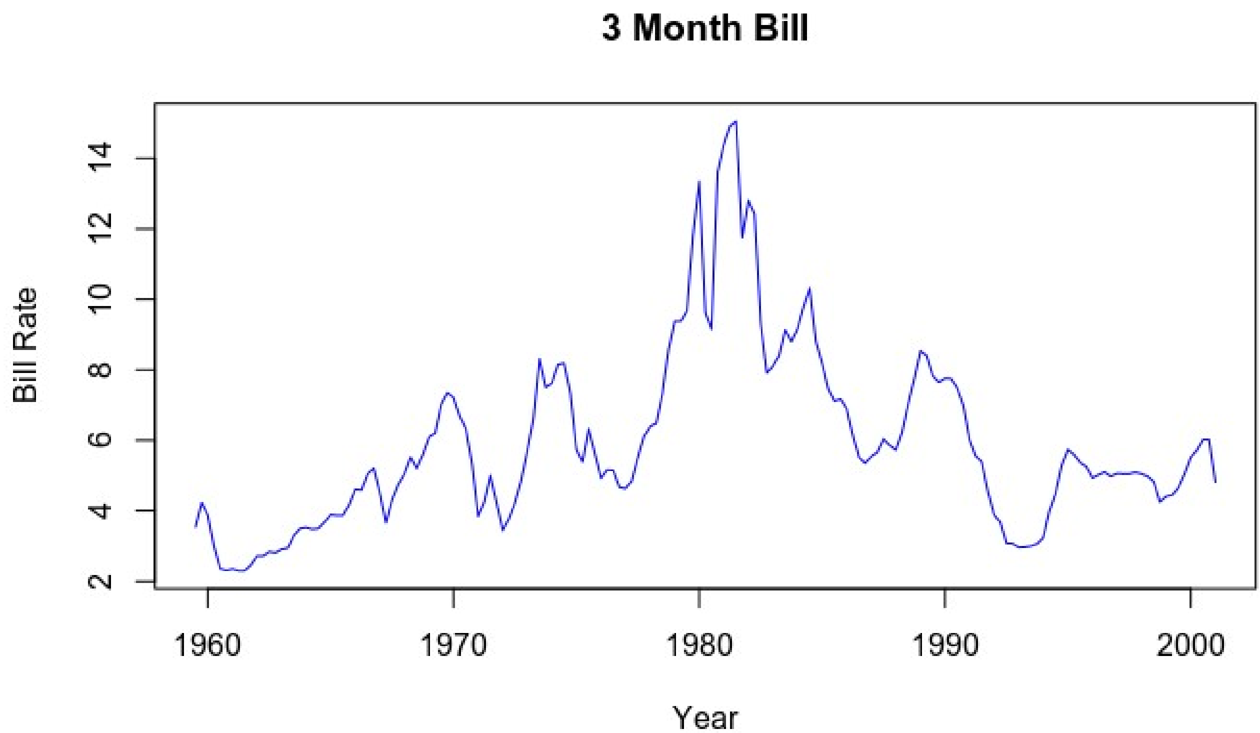
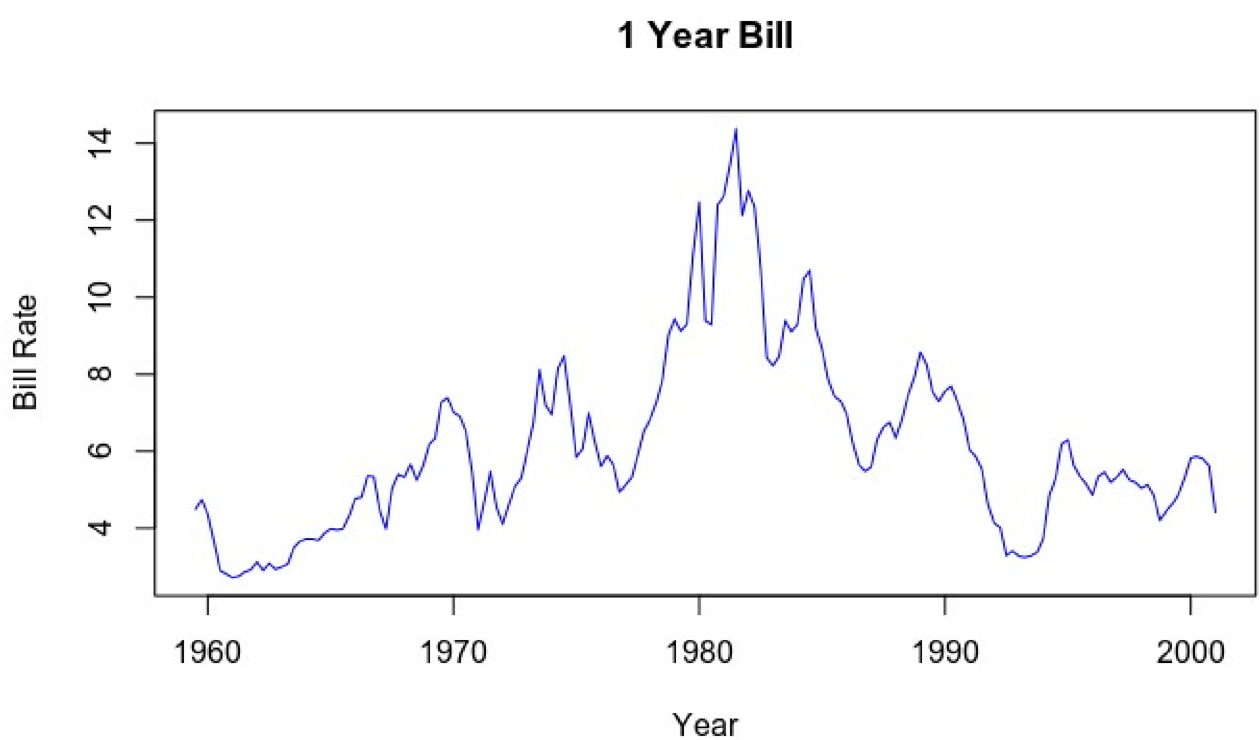
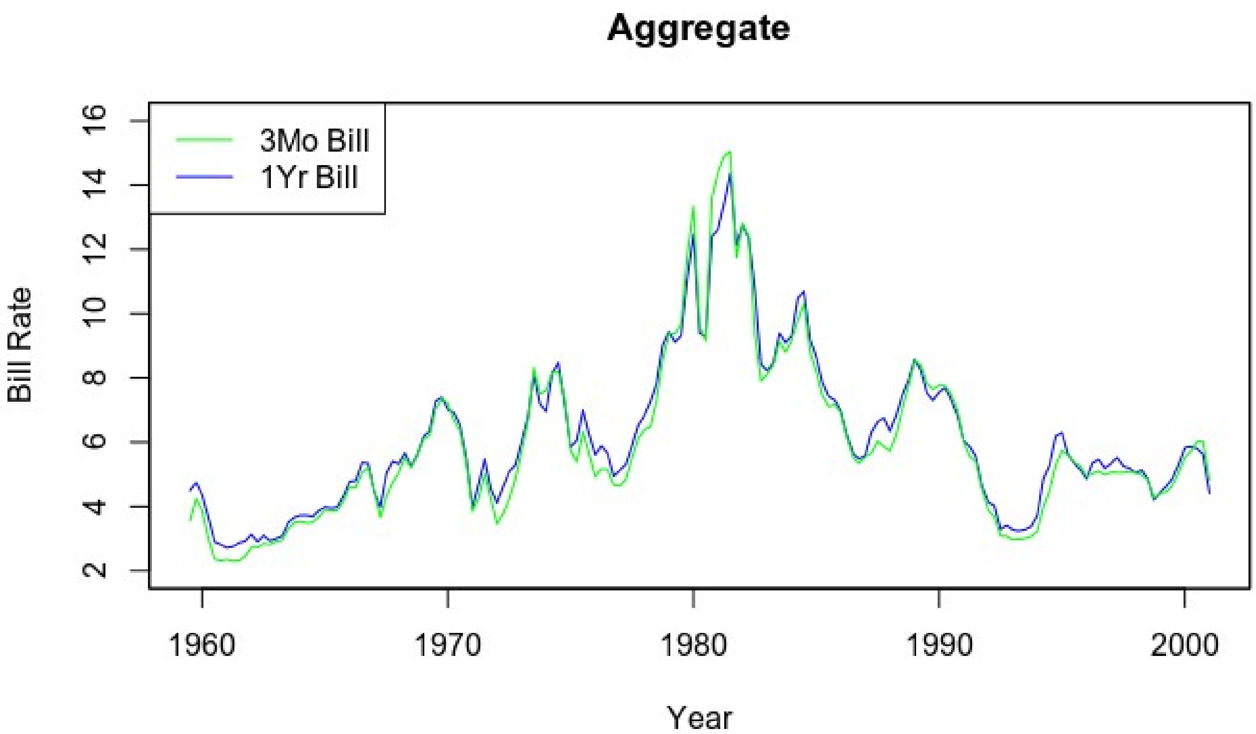
a) Neither of the graphs below appear to have a constant mean or variance.





b) In general, the two time series appear to move together, with the 1 year bill rate being slightly above the 3 month rate most of the time.



c) OLS gives the formula *tb1yr = 0.6982 + 0.9167*tb3mo*.

```
Call:
lm(formula = tb1yr.ts ~ tb3mo.ts, data = data.df)

Coefficients:
(Intercept)     tb3mo.ts
     0.6982       0.9167
```

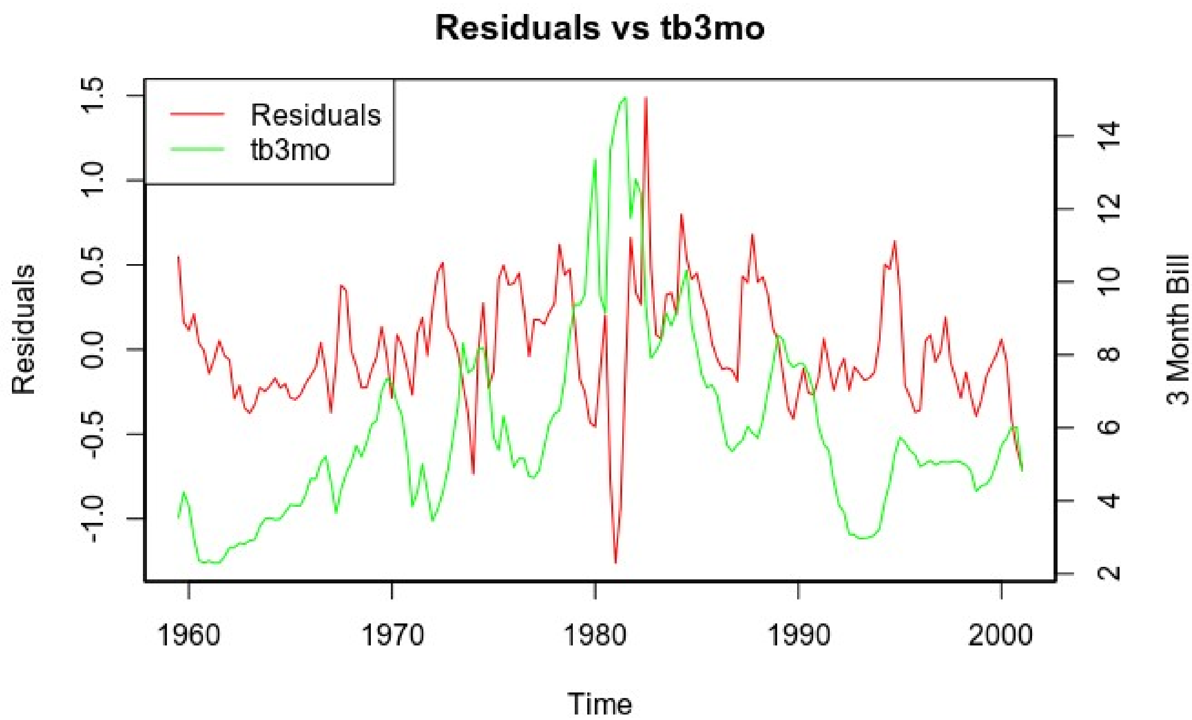
d) The OLS regression confirms what we see in part (b): the time series move together in a near 1-to-1 fashion, with the 1 year rate being slightly higher than the 3 month rate.

e) Running `summary(ols)` shows a std. error of 0.01 for the beta coefficient. Thus we have

$$\frac{0.9167-1}{0.01}=-8.33$$

and reject the null that B=1. Though we do expect to see some positive correlation between the short and long term bill rates, it is not surprising that they would not be exactly 1-to-1.

f) Sometimes the residuals move with the 3 month bill, sometimes the residuals move in the opposite direction; there is no clear pattern. This seems to suggest that the errors are heteroskedastic.



g) First, we create a linear model `lm(u2 ~ y + I(y^2)` where u2 is the squared residuals of our estimator from (c). The R^2 value of this model is then calculated, and using LM = nR^2 gives LM=25.91. The p-value is calculated using 1-pchisq(LM, 2), and shown to be 2.4e-6. Thus we reject the null of homoskedacitity, as expected.
The built-in bptest() yields similar results.

h) Running `coeftest(ols, vcov = vcovHC(ols, type="HC1"))` gives the formula *tb1yr = 0.6982 + 0.9167*tb3mo*, with standard errors 0.0884 and 0.0167 for the intercepts and tb3mo variable, respectively.

i) The coefficients remain the same (as we would expect), but the robust standard errors are different.

j) OLS gives the formula *tb1yr = 0.556 + 0.945*tb3mo - 0.444*d*.

```
Call:
lm(formula = tb1yr.ts ~ tb3mo.ts + dummy, data = data.df)

Coefficients:
(Intercept)     tb3mo.ts        dummy
     0.5557       0.9451      -0.4443
```

k) Running `summary(ols)` shows a std. err of 0.1516 for the dummy variable coefficient. Thus we have

$$\frac{-0.444-0}{0.1516}=-2.93$$

and a low p-value (0.004), so we conclude that the dummy variable is relevant.

l)

```
> table
                   ols        ols2   Difference
r-squared   0.979727121   0.980736435   0.001009314
AIC       119.355120175 112.826684334  -6.528435841
```

```
#CODE
# Load the data and create variables
data.df <- read.csv("~/Downloads/1606.csv",header=TRUE, sep="\t")
tb3mo.ts <- ts(data=data.df[c("TB3mo")], frequency=4, start=c(1959,3), end=c(2001,1))
tb1yr.ts <- ts(data=data.df[c("TB1yr")], frequency=4, start=c(1959,3), end=c(2001,1))

#Individual Plots
plot(tb3mo.ts, col="blue", ylab="Bill Rate", main="3 Month Bill", xlab="Year")
plot(tb1yr.ts, col="blue", ylab="Bill Rate", main="1 Year Bill", xlab="Year")

# Aggregate Plot
plot(tb1yr.ts, col="blue", ann=FALSE, ylim=range(2,16))
lines(tb3mo.ts, col="green")
box()
title(main="Aggregate")
title(xlab="Year")
title(ylab="Bill Rate")
legend("topleft", legend=c("3Mo Bill", "1Yr Bill"), lty=c(1,1),col=c("green","blue"))

#OLS
ols <- lm(tb1yr.ts ~ tb3mo.ts, data=data.df)
ols
y <- fitted(ols)

residuals.ts <- tb1yr.ts - 0.9167*tb3mo.ts - 0.6982
u2 <- (residuals.ts)^2
Ru2<- summary(lm(u2 ~ y + y^2))$r.squared
LM <- nrow(data.df)*Ru2
p.value <- 1-pchisq(LM, 2)
p.value

par(mar = c(5, 5, 3, 5))
plot(residuals.ts, col="red", ylab="Residuals")
mtext("3 Month Bill", side = 4, line=3)
par(new=TRUE)
plot(tb3mo.ts, col="green", xaxt="n", yaxt="n", ylab="", xlab="")
axis(side=4)
box()
title(main="Residuals vs tb3mo")
legend("topleft", c("Residuals", "tb3mo"), col = c("red", "green"), lty=c(1,1))

#OLS w/ Dummy Var
dummy <- tb3mo.ts
```

```
for (i in 1:nrow(dummy)){
  for (j in 1:ncol(dummy)){
    if (dummy[i,j] > 10) dummy[i] <- 1
    else dummy[i,j] <- 0
  }
}
ols2 <- lm(tb1yr.ts ~ tb3mo.ts + dummy, data=data.df)
ols2
y2 <- fitted(ols2)


#Compare ols with ols2
ols.r2 <- summary(ols)$r.squared
ols2.r2 <- summary(ols2)$r.squared
#ols.X2 <- chisq.test(y, tb1yr.ts)
#ols2.X2 <- chisq.test(y2, tb1yr.ts)
ols.aic <- AIC(ols)
ols2.aic <- AIC(ols2)
table <- matrix(c(ols.r2, ols2.r2, ols2.r2-ols.r2,ols.aic, ols2.aic, ols2.aic-ols.aic), ncol=3, byrow
=TRUE)
colnames(table) <- c("ols", "ols2", "Difference")
rownames(table) <- c("r-squared", "AIC")
table <- as.table(table)
table
```