---problem 1---

```
setwd("C:/Users/47494/GitHub/MF793/data")
monthly_rets <- read.csv("stk-mon.csv",header=T)
daily_rets <- read.csv("stk-day.csv",header=T)
```

 # (a)

```
log_monthly_rets <- cbind(monthly_rets$date,log(1 + monthly_rets[,2:13]))
log_monthly_rets[,14] <- rowMeans(log_monthly_rets[,2:12])
names(log_monthly_rets)[c(1,14)] <- c('date','ewret')
log_monthly_rets_a <- log_monthly_rets[log_monthly_rets$date<='20151231',]
log_monthly_rets_b <- log_monthly_rets[log_monthly_rets$date>'20151231',]
monthly_sd_a <- apply(log_monthly_rets_a[,2:14], 2, sd)
monthly_sd_b <- apply(log_monthly_rets_b[,2:14], 2, sd)
ann_monthly_sd_a <- monthly_sd_a * sqrt(12)
ann_monthly_sd_b <- monthly_sd_b * sqrt(12)
round(ann_monthly_sd_a, 3)
round(ann_monthly_sd_b, 3)
monthly_vr <- ann_monthly_sd_a^2 / ann_monthly_sd_b^2
round(monthly_vr, 3)
```

Table 1: Volatility for the 2010-15 and 2016-17 periods

	σ_{1M} (ann.)	σ_{2M} (ann.)	VR_M	σ_{1D} (ann.)	σ_{2D} (ann.)	VR_D
Apple	0.247	0.235	1.102	0.267	0.207	1.667
Amazon	0.281	0.224	1.571	0.327	0.255	1.643
Biogen	0.293	0.284	1.067	0.324	0.295	1.204
Citygroup	0.301	0.254	1.409	0.345	0.257	1.800
GE	0.222	0.189	1.376	0.224	0.188	1.433
Nike	0.213	0.186	1.319	0.235	0.221	1.135
Pepsi	0.117	0.111	1.126	0.142	0.118	1.450
State Street	0.242	0.265	0.831	0.274	0.248	1.225
Toyota	0.193	0.174	1.234	0.222	0.189	1.381
Valero	0.348	0.235	2.190	0.359	0.271	1.760
Verizon	0.165	0.177	0.868	0.163	0.165	0.975
US VW	0.133	0.080	2.759	0.161	0.108	2.241
EW 11	0.145	0.110	1.735	0.174	0.126	1.910

 # (b)

```
montly_cutoffs <- qf(c(0.05, 0.95), 71, 23)
round(montly_cutoffs, 3)
barplot(monthly_vr, main="barplot of VRs", ylim=c(0,3))
abline(h=1,lwd=3)
abline(h=montly_cutoffs[2],lwd=3)
round(sqrt(1/monthly_vr[12]) - 1, 3)
```

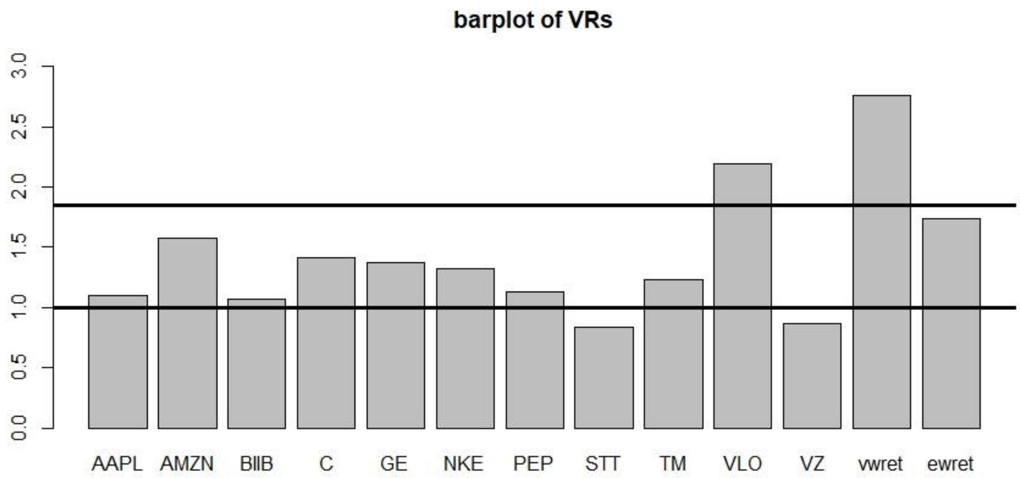


Figure 1

 # (c)

```
log_daily_rets <- cbind(daily_rets$date,log(1 + daily_rets[,2:13]))
log_daily_rets[,14] <- rowMeans(log_daily_rets[,2:12])
names(log_daily_rets)[c(1,14)] <- c('date','ewret')
log_daily_rets_a <- log_daily_rets[log_daily_rets$date<='20151231',]
log_daily_rets_b <- log_daily_rets[log_daily_rets$date>'20151231',]
daily_sd_a <- apply(log_daily_rets_a[,2:14], 2, sd)
daily_sd_b <- apply(log_daily_rets_b[,2:14], 2, sd)
ann_daily_sd_a <- daily_sd_a * sqrt(252)
ann_daily_sd_b <- daily_sd_b * sqrt(252)
round(ann_daily_sd_a, 3)
round(ann_daily_sd_b, 3)
daily_vr <- ann_daily_sd_a^2 / ann_daily_sd_b^2
round(daily_vr, 3)
daily_cutoffs <- qf(c(0.05, 0.95), 1509, 502)
round(daily_cutoffs, 3)
```

 # (d)

```
vw_monthly_mean <- mean(log_monthly_rets[,13])
vw_monthly_sd <- sd(log_monthly_rets[,13])
sim_monthly_ret <- matrix(
    rnorm(96*20000, mean=vw_monthly_mean, sd=vw_monthly_sd),
    ncol=20000)
sim_monthly_ret_a <- sim_monthly_ret[1:72,]
sim_monthly_ret_b <- sim_monthly_ret[73:96,]
sim_monthly_sd_a <-apply(sim_monthly_ret_a, 2, sd)
sim_monthly_sd_b <-apply(sim_monthly_ret_b, 2, sd)
sim_monthly_vr <- sim_monthly_sd_a^2 / sim_monthly_sd_b^2
round(quantile(sim_monthly_vr,0.95), 3)
```

```
round(mean(sim_monthly_vr),3)
monthly_frac <- sum(sim_monthly_vr > qf(0.95, 71, 23))/length(sim_monthly_vr)

sim_daily_ret <- matrix(rt(2016*20000,6),ncol=20000)
sim_daily_ret_a <- sim_daily_ret[1:1512,]
sim_daily_ret_b <- sim_daily_ret[1513:2016,]
sim_daily_sd_a <-apply(sim_daily_ret_a, 2, sd)
sim_daily_sd_b <-apply(sim_daily_ret_b, 2, sd)
sim_daily_vr <- sim_daily_sd_a^2 / sim_daily_sd_b^2
round(quantile(sim_daily_vr,0.95), 3)
round(mean(sim_daily_vr),3)
daily_frac <- sum(sim_daily_vr > qf(0.95, 1511, 503))/length(sim_daily_vr)

qqplot(qf(ppoints(20000),71,23),sim_monthly_vr,
   main="F-probability plot of VRs against theoretical F\nmonthly case",
   xlab="theoretical quantiles", ylab="sample quantiles")
abline(0,1)
```

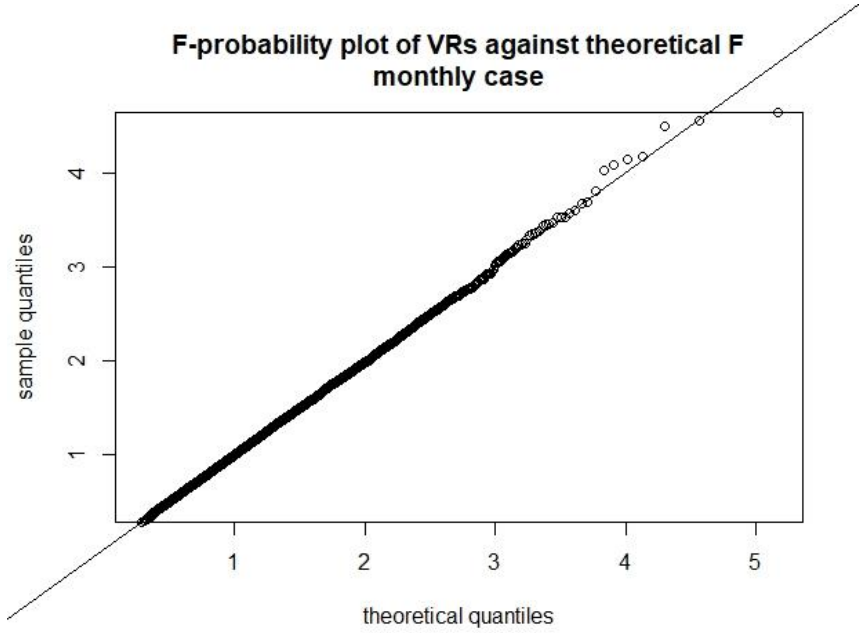


Figure 2a

```
qqplot(qf(ppoints(20000),1511,503),sim_daily_vr,
         main="F-probability plot of VRs against theoretical F\ndaily case",
         xlab="theoretical quantiles", ylab="sample quantiles")
abline(0,1)
```

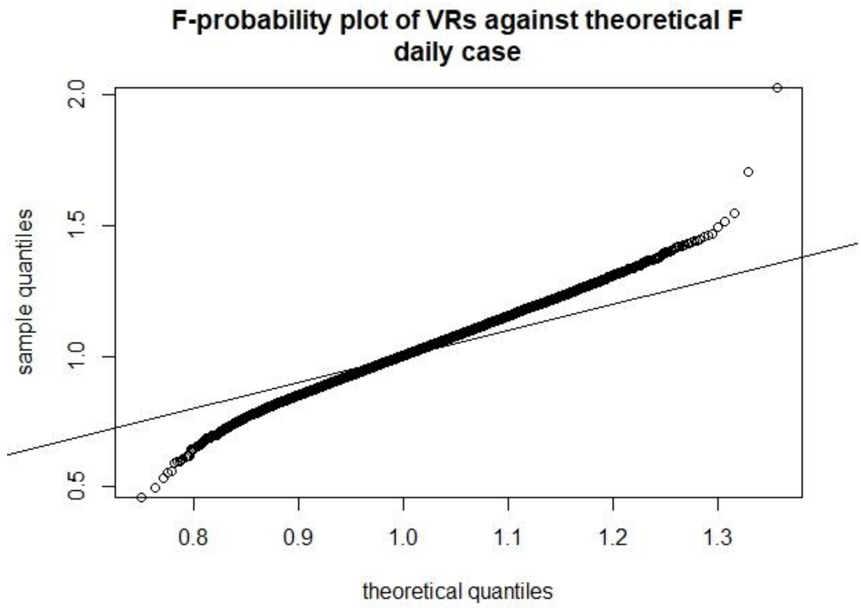


Figure 2b

Table 2: Theoretical and simulated Mean and 95th quantiles of the Chow Test

	ν_1	ν_2	$F_{0.95}$	Frac	$VR_{0.95}$	E(F)	$\overline{VR}$
Monthly, Normal	71	23	1.849	4.85%	1.840	1.095	1.094
Daily, t(6)	1511	503	1.130	13.71%	1.197	1.004	1.009
Normal ρ = 0.3	95	95	1.404	4.11%	1.379	1.022	1.019
Normal $\rho_{C,STT}$ =0.73	95	95	1.404	0.86%	1.263	1.022	1.011

---problem 2---

 # (a)

```
C_mothly_ret <- log_monthly_rets[,5]
STT_mothly_ret <- log_monthly_rets[,9]
C_mothly_sd <- sd(C_mothly_ret)
STT_mothly_sd <- sd(STT_mothly_ret)
monthly_vr_CS <- C_mothly_sd^2 / STT_mothly_sd^2
round(monthly_vr_CS,3)
round(qf(c(0.05,0.95),95,95),3)
```

 # (b)

```
sim_monthly_ret2_a <- matrix(
   rnorm(96*20000),ncol=20000)
sim_monthly_ret2_b <- 0.3*sim_monthly_ret2_a +
   sqrt(1-0.3^2)*matrix(rnorm(96*20000),ncol=20000)
sim_monthly_sd2_a <- apply(sim_monthly_ret2_a, 2, sd)
sim_monthly_sd2_b <- apply(sim_monthly_ret2_b, 2, sd)
sim_monthly_vr2 <- sim_monthly_sd2_a^2 / sim_monthly_sd2_b^2
```

```
round(quantile(sim_monthly_vr2, 0.95), 3)
round(mean(sim_monthly_vr2),3)
monthly_frac2 <- sum(sim_monthly_vr2 > qf(0.95, 95, 95))/length(sim_monthly_vr2)

rho <- cor(C_mothly_ret, STT_mothly_ret)
sim_monthly_ret3_a <- matrix(
   rnorm(96*20000),ncol=20000)
sim_monthly_ret3_b <- rho*sim_monthly_ret3_a +
   sqrt(1-rho^2)*matrix(rnorm(96*20000),ncol=20000)
sim_monthly_sd3_a <- apply(sim_monthly_ret3_a, 2, sd)
sim_monthly_sd3_b <- apply(sim_monthly_ret3_b, 2, sd)
sim_monthly_vr3 <- sim_monthly_sd3_a^2 / sim_monthly_sd3_b^2
round(quantile(sim_monthly_vr3, 0.95), 3)
round(mean(sim_monthly_vr3),3)
monthly_frac3 <- sum(sim_monthly_vr3 > qf(0.95, 95, 95))/length(sim_monthly_vr3)
qqplot(qf(ppoints(20000),95,95),sim_monthly_vr3,
   main="F-probability plot of VRs against theoretical F\nC / STT monthly case",
   xlab="theoretical quantiles", ylab="sample quantiles")
abline(0,1)
qqplot(qt(ppoints(20000),95,95),sim_monthly_vr3,
   main="t-probability plot of VRs with\ndegree of freedom=95\nnon-centrality parameter=95",
   xlab="theoretical quantiles", ylab="sample quantiles")
```

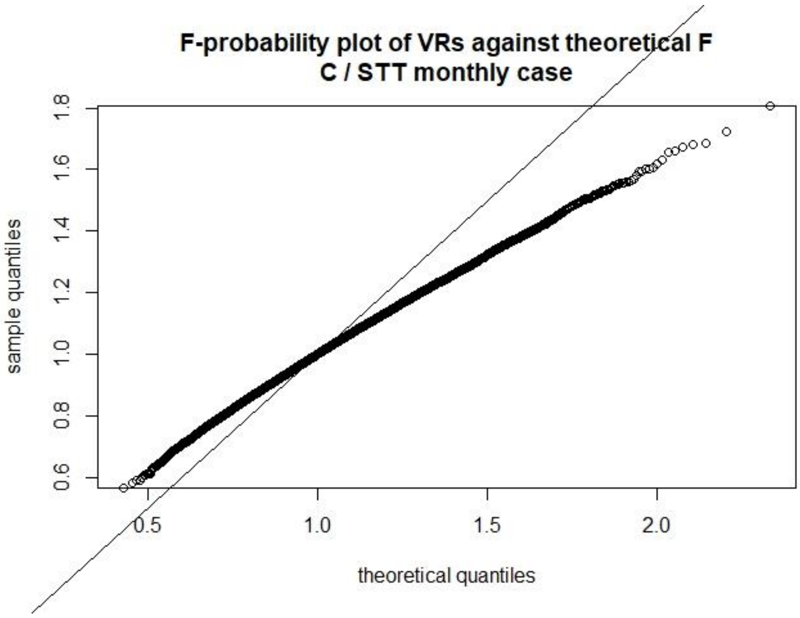
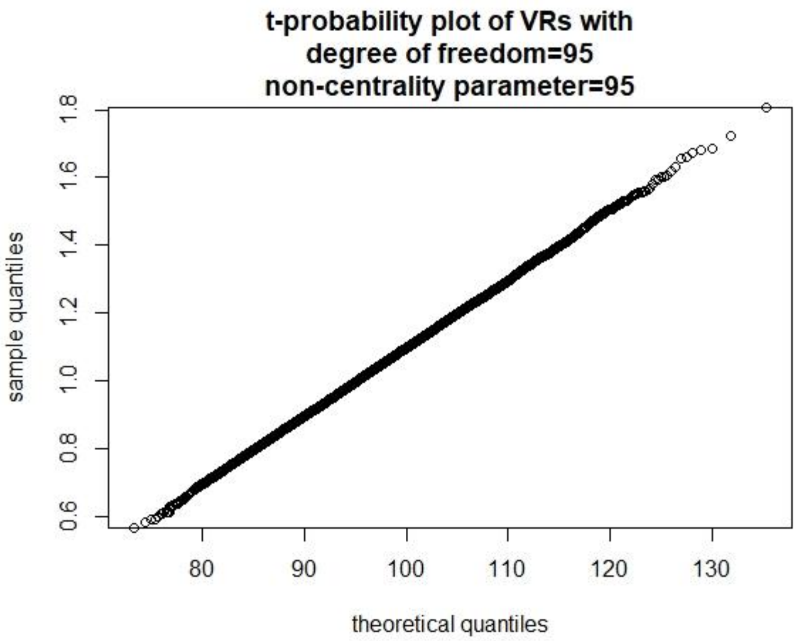


Figure 3


t-probability plot of VRs with
degree of freedom=95
non-centrality parameter=95
sample quantiles
0.6
0.8
1.0
1.2
1.4
1.6
1.8
80
90
100
110
120
130
theoretical quantiles