

FIN 503 Quantitative Finance II Homework 3  
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1.

(1)

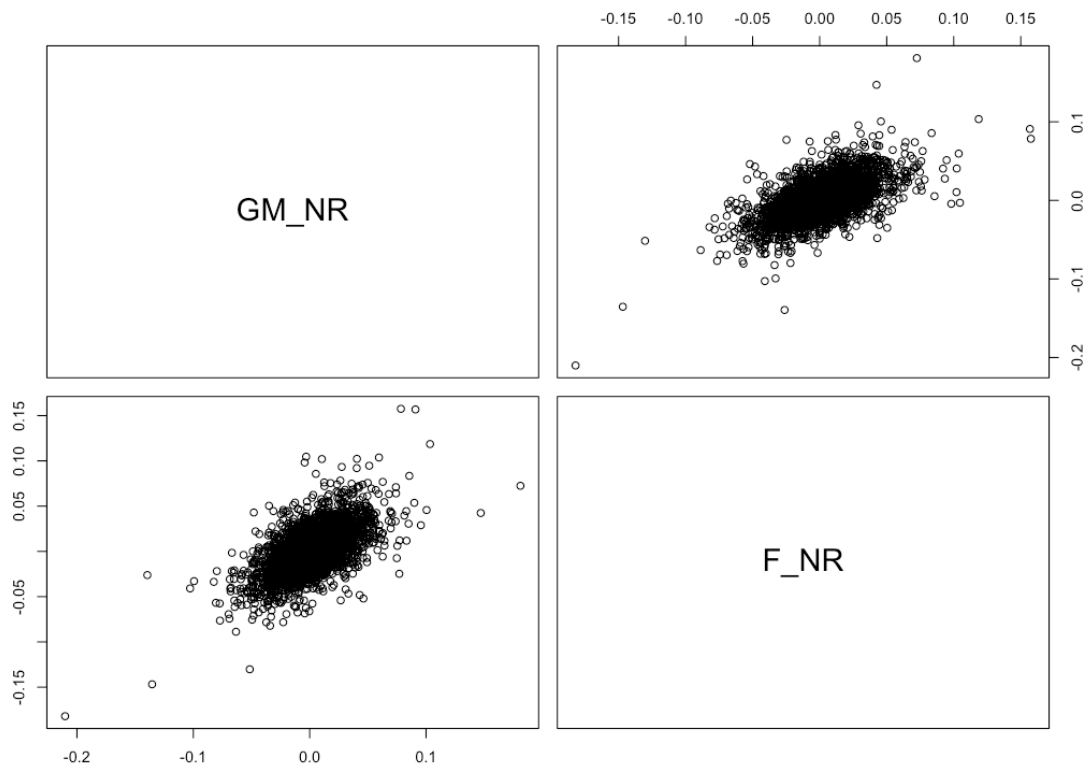
GM net returns(we'll skip the rest of the numbers):

```
> GM_NR = diff(GM_AC)/lag(GM_AC)
Warning message:
In diff(GM_AC)/lag(GM_AC) :
  longer object length is not a multiple of shorter object length
> GM_NR
[1] 0.024454148 0.003410060 0.005097706 -0.014370245 0.009433962 -0.001699235 -0.009361702 -0.007731959
[9] 0.015584416 0.003410060 0.017841971 0.015859766 -0.004930156 0.023121387 -0.031476998 -0.001666667
[17] 0.023372287 0.004893964 0.045454545 0.000000000 0.034937888 -0.018004501 0.024446142 0.020879940
[25] -0.032870709 0.000000000 -0.006797583 -0.006844106 0.000000000 0.012251149 0.022692890 -0.006656805
[33] 0.003723008 -0.009643917 -0.002247191 0.003753754 -0.024682124 -0.008435583 0.003866976 0.001540832
[41] 0.011538462 0.050950570 -0.017366136 -0.007363770 0.012611276 0.006593407 -0.009461426 -0.003673769
[49] -0.001474926 -0.011078287 0.008215086 -0.003703704 0.005204461 0.004437870 0.014727541 0.001451379
[57] 0.000000000 0.007971014 -0.026599569 -0.012555391 0.015706806 0.008100147 -0.001460920 0.014630578
[65] 0.021629416 0.009174312 0.024475524 -0.011604096 0.032458564 -0.020066890 -0.016382253 0.037473976
[73] 0.008695652 -0.011273210 0.039570758 -0.020000000 0.005924951 -0.018324607 0.004000000 -0.003984064
[81] 0.012666667 0.030283081 0.017891374 -0.003766478 0.005040958 0.000000000 -0.002507837 -0.005656820
[89] 0.000000000 0.003160556 -0.005671078 -0.011406844 -0.009615385 -0.005825243 -0.022786458 -0.014656895
[97] -0.009465855 0.013651877 0.006060606 -0.010040161 0.016227181 0.000000000 0.000000000 -0.010645376
[105] 0.024209818 0.000000000 -0.005909389 0.004623514 -0.001972387 -0.024374177 0.004051317 -0.005379960
[113] -0.003380663 -0.010176391 -0.007539411 0.010359116 0.004784689 0.007482993 0.000000000 0.000000000
[121] 0.001350439 -0.004720162 0.002032520 -0.014874915 -0.015099520 -0.002090592 -0.015363128 0.009929078
[129] 0.002808989 -0.004901961 0.014074595 0.018736988 0.023841962 -0.010645376 -0.012777404 0.004087193
[137] -0.001356852 -0.002717391 0.008855586 0.017555706 0.014598540 -0.002616089 -0.005901639 0.004617414
```

Ford net returns(we'll skip the rest of the numbers):

```
> F_NR = diff(F_AC)/lag(F_AC)
Warning message:
In diff(F_AC)/lag(F_AC) :
  longer object length is not a multiple of shorter object length
> F_NR
[1] 0.038961039 0.012500000 0.041152263 -0.007905138 0.015936255 0.019607843 0.015384615 0.045454545 0.021739130
[10] -0.007092199 0.003571429 0.014234875 0.010526316 0.065972222 -0.032573290 -0.003367003 0.020270270 -0.003311258
[19] 0.000000000 -0.003322259 0.020000000 0.003267974 0.013029316 0.032154341 -0.028037383 -0.022435897 -0.026229508
[28] 0.020202020 -0.003300330 0.016556291 0.035830619 0.000000000 0.003144654 -0.015673981 -0.012738854 0.003225806
[37] 0.006430868 -0.019169329 0.003257329 0.012987013 -0.006410256 0.032258065 0.006250000 0.015527950 0.009174312
[46] 0.003030303 0.006042296 -0.012012012 -0.021276596 -0.015527950 0.022082019 0.000000000 0.006172840 0.006134969
[55] 0.012195122 -0.009036145 0.027355623 0.005917160 -0.011764706 -0.014880952 0.027190332 0.032352941 -0.011396011
[64] 0.017291066 0.031161473 -0.013736264 -0.002785515 -0.027932961 0.000000000 -0.011494253 -0.034883721 0.006024096
[73] 0.023952096 -0.026315789 0.036036036 -0.008695652 0.005847953 -0.034883721 -0.012048193 0.015243902 0.072072072
[82] 0.039215686 0.075471698 -0.005012531 0.000000000 0.015113350 0.012406948 -0.002450980 -0.027027027 -0.007575758
[91] 0.012722646 -0.012562814 -0.027989822 -0.031413613 -0.018918919 -0.013774105 0.011173184 0.019337017 0.016260163
[100] -0.002666667 -0.016042781 0.005434783 0.010810811 -0.005347594 0.034946237 -0.002597403 -0.005208333 0.005235602
[109] 0.005208333 -0.010362694 -0.002617801 -0.002624672 0.042105263 0.010101010 -0.032500000 0.005167959 0.005141388
[118] 0.002557545 0.002551020 0.005089059 0.027848101 0.022167488 -0.012048193 -0.017073171 -0.004962779 0.009975062
[127] -0.017283951 0.020100503 0.017241379 -0.004842615 0.009732360 0.014457831 0.030878860 0.000000000 0.004608295
[136] 0.009174312 -0.013636364 0.000000000 -0.002304147 -0.023094688 0.002364066 -0.011792453 -0.007159905 0.004807692
```

Plot GM net returns versus the Ford net returns:



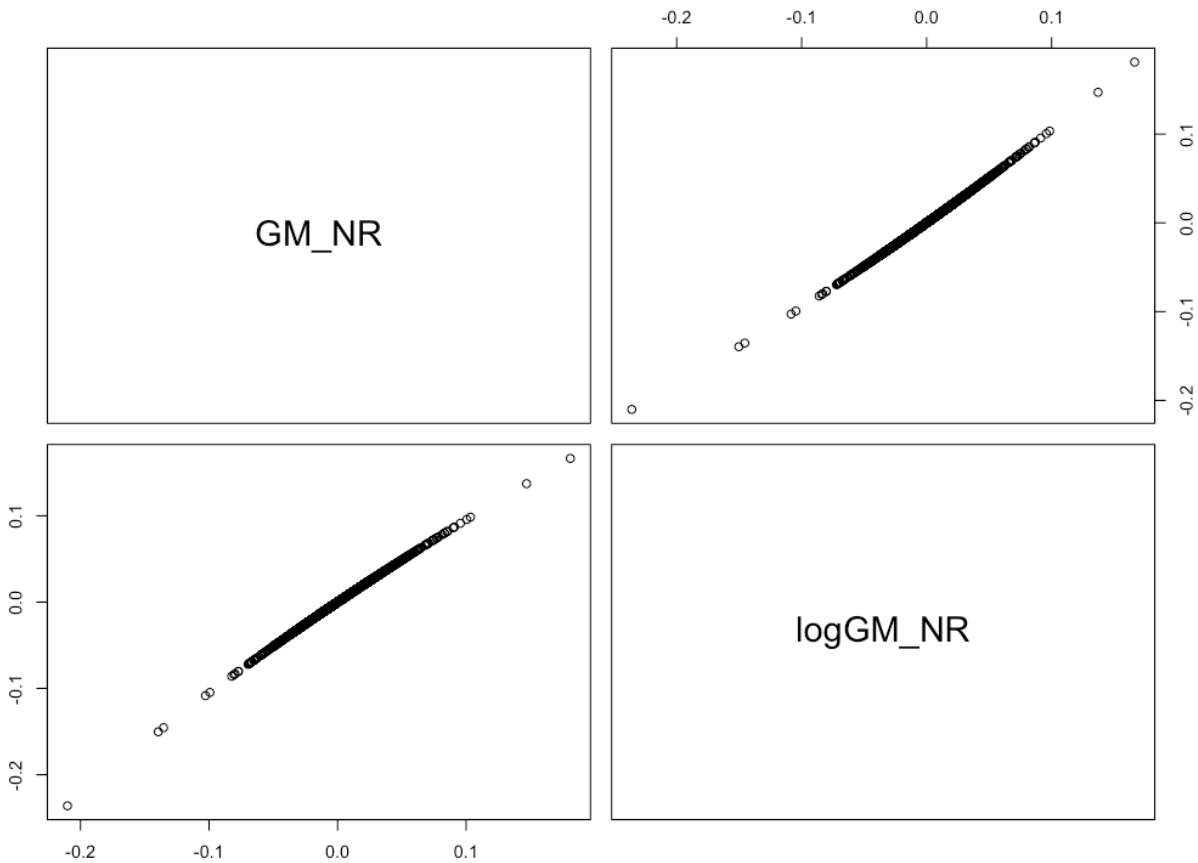
Judging from the plot, net returns of GM and Ford seem positively correlated.

(2)

Log returns of GM:

```
> logGM_NR <- log(1+GM_NR)
> logGM_NR
[1] 0.024159933 0.003404259 0.005084757 -0.014474497 0.009389740 -0.001700681 -0.009405798 -0.007762005 0.015464226
[10] 0.003404259 0.017684671 0.015735314 -0.004942349 0.022858138 -0.031983046 -0.001668057 0.023103338 0.004882028
[19] 0.044451763 0.000000000 0.034341414 -0.018168554 0.024152117 0.020664942 -0.033423089 0.000000000 -0.006820792
[28] -0.006867635 0.000000000 0.012176711 0.022439236 -0.006679060 0.003716095 -0.009690721 -0.002249720 0.003746726
[37] -0.024991835 -0.008471364 0.003859518 0.001539646 0.011472401 0.049695060 -0.017518696 -0.007391017 0.012532416
[46] 0.006571765 -0.009506470 -0.003680534 -0.001476015 -0.011140108 0.008181526 -0.003710579 0.005190965 0.004428052
[55] 0.014620143 0.001450327 0.000000000 0.007939414 -0.026959738 -0.012634876 0.015584731 0.008067517 -0.001461989
[64] 0.014524584 0.021398819 0.009132484 0.024180798 -0.011671949 0.031942913 -0.020270964 -0.016517925 0.036788890
[73] 0.008658063 -0.011337234 0.038807895 -0.020202707 0.005907467 -0.018494583 0.003992021 -0.003992021 0.012587116
[82] 0.029833600 0.017733207 -0.003773589 0.005028295 0.000000000 -0.002510987 -0.005672880 0.000000000 0.003155572
[91] -0.005687219 -0.011472401 -0.009661911 -0.005842276 -0.023050082 -0.014765369 -0.009510941 0.013559530 0.006042314
[100] -0.010090903 0.016096927 0.000000000 0.000000000 -0.010702443 0.023921406 0.000000000 -0.005926919 0.004612858
[109] -0.001974334 -0.024676144 0.004043132 -0.005394484 -0.003386390 -0.010228524 -0.007567976 0.010305828 0.004773279
[118] 0.007455134 0.000000000 0.000000000 0.001349528 -0.004731337 0.002030458 -0.014986657 -0.015214678 -0.002092781
[127] -0.015482364 0.009880109 0.002805051 -0.004914015 0.013976468 0.018563613 0.023562181 -0.010702443 -0.012859737
[136] 0.004078864 -0.001357773 -0.002721090 0.008816605 0.017403384 0.014493007 -0.002619517 -0.005919123 0.004606787
```

Plot the net returns versus the log returns of GM.



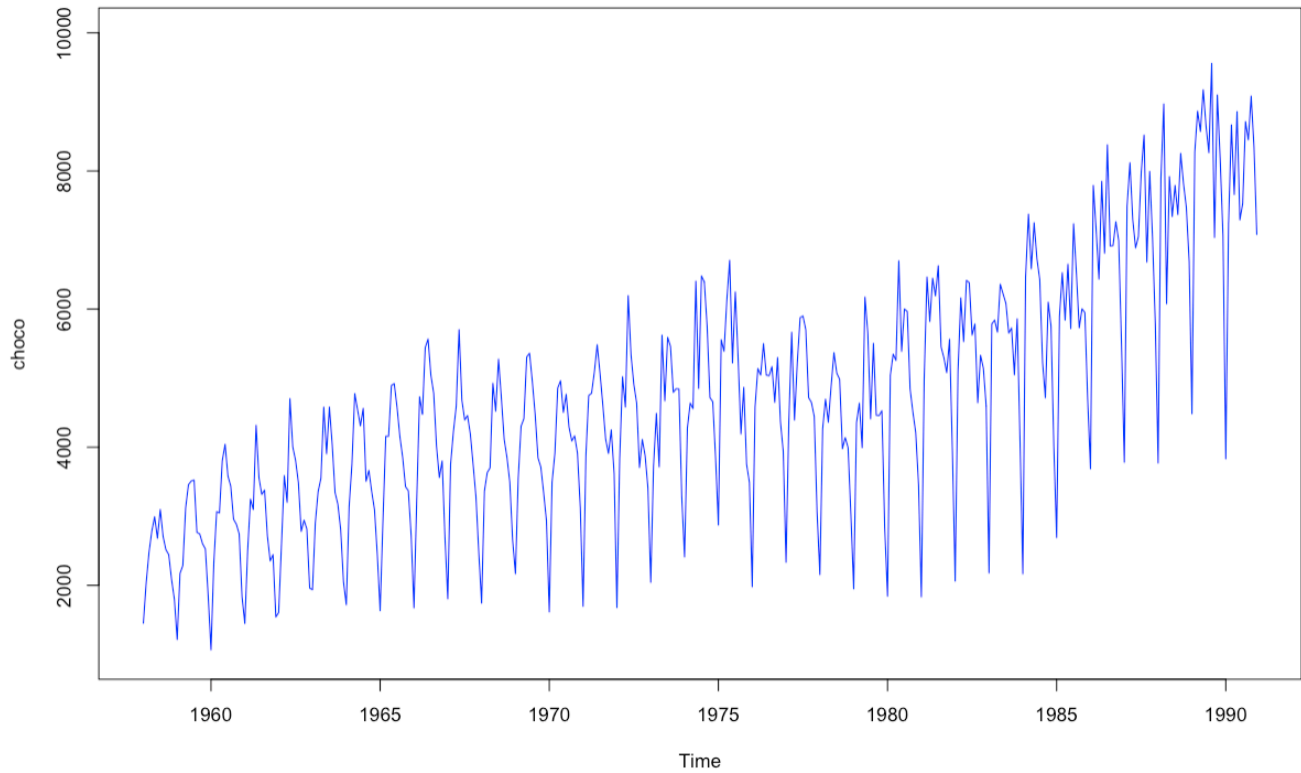
As shown in the plot, the data of GM\_NR and logGM\_NR forms a line with positive slope. Also, the correlation coefficient of GM\_NR and logGM\_NR is 0.9995408, indicating that the two returns are highly and positively correlated.

```
> cor(GM_NR, logGM_NR)
[1] 0.9995408
```

2.

(1) Time plot of monthly chocolate production:

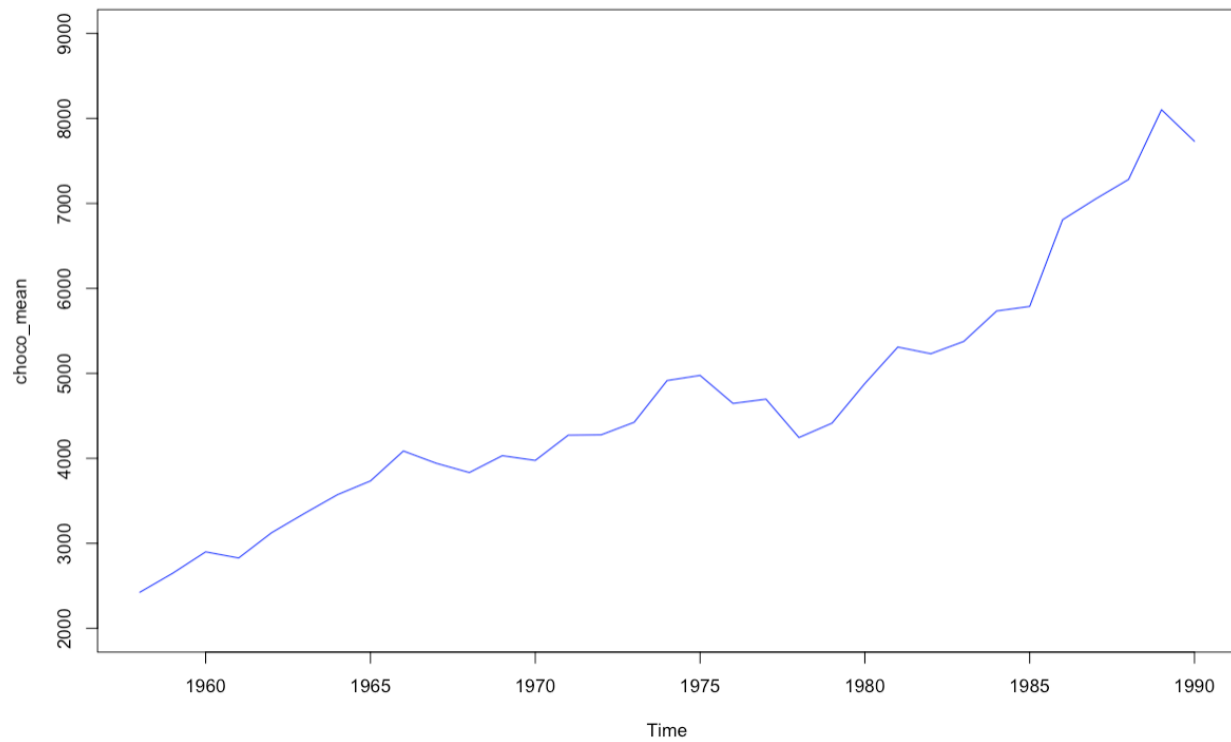
**Time Plot of Monthly Chocolate Productions**



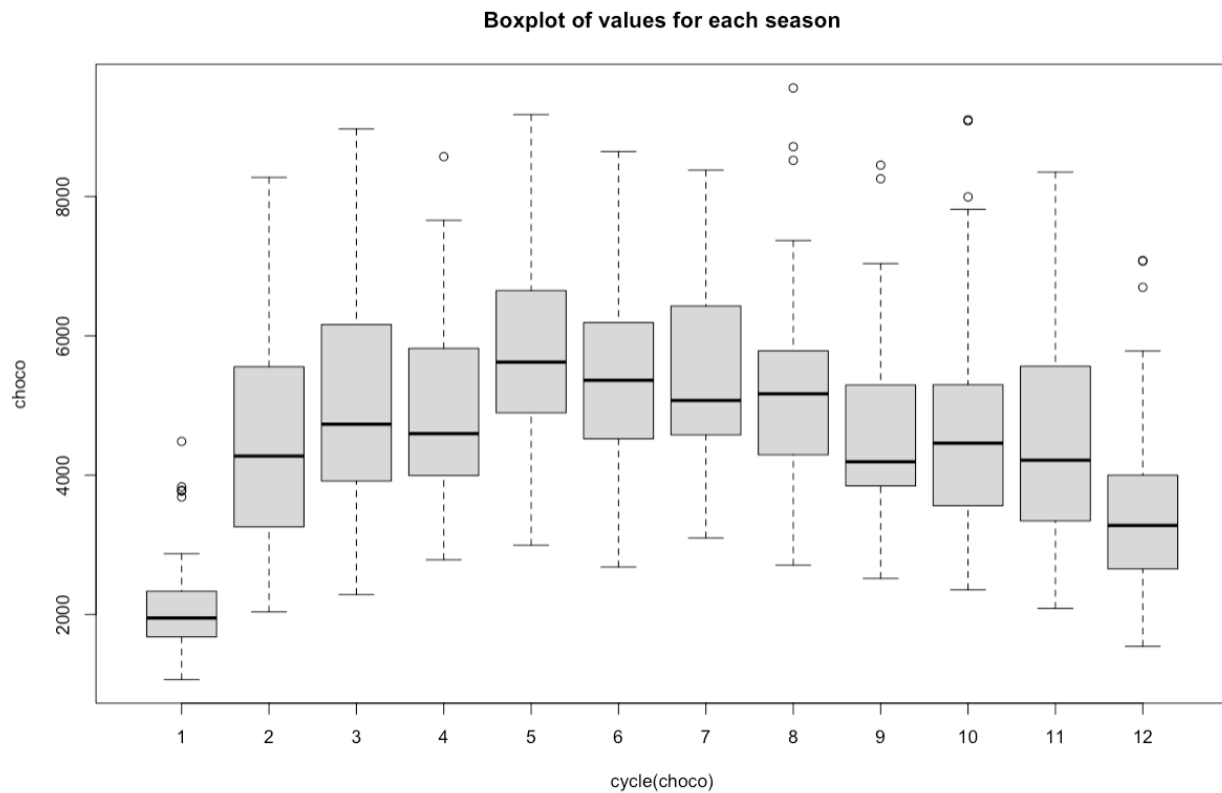
(2)

Aggregated annual series:

**Aggregated Annual Series**



### (3) Boxplot:



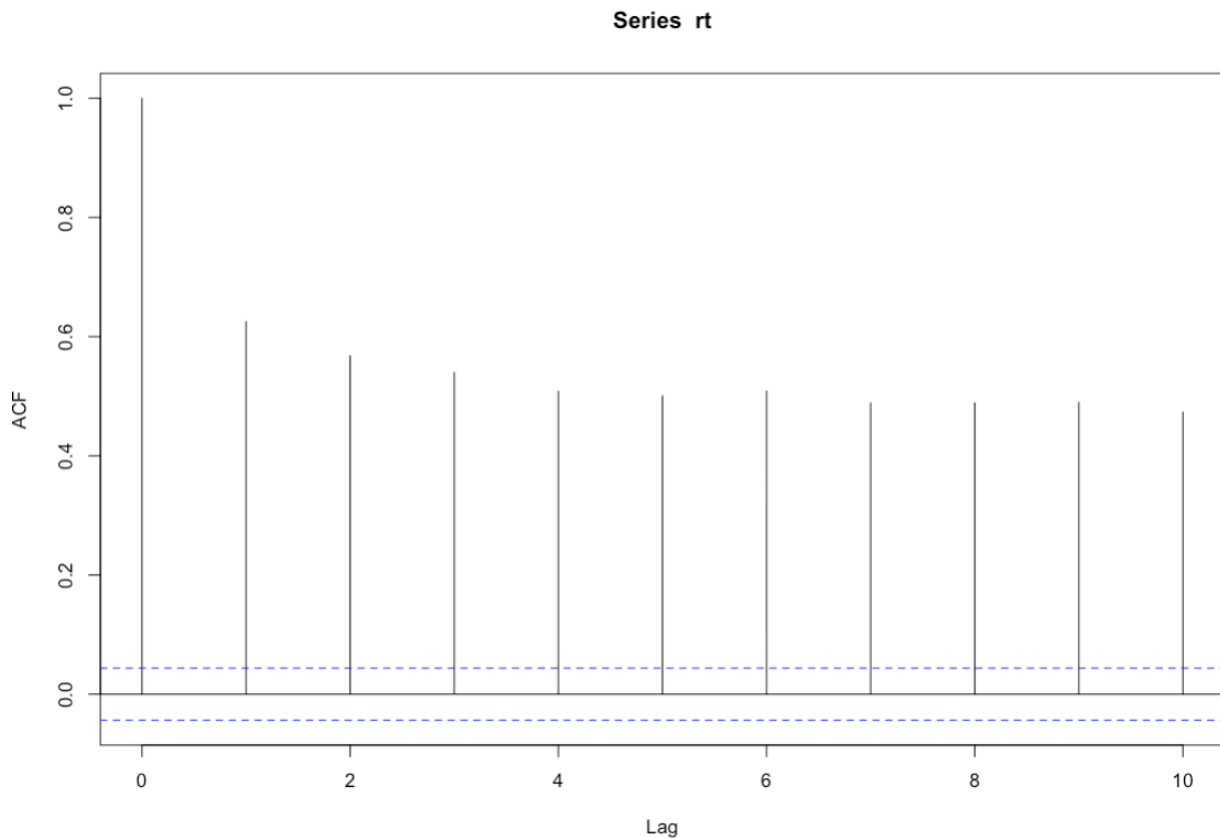
From the time plot, we can already see that there's a plunge in chocolate production every year. With the help of the boxplot, we can see that the plunge happens in January. After January, the amount of chocolate produced tends to increase slightly and peak in May, then decrease gradually throughout the year.

3.

(1) Daily log price range(we'll skip the rest of the numbers):

```
> logHt <- log(1+ASKHI)
> logLt <- log(1+BIDLO)
> rt <- logHt-logLt
> rt
 [1] 0.074325497 0.073069011 0.062303883 0.055512710 0.029914557 0.030674007 0.042296145
 [8] 0.028749413 0.035055136 0.034521194 0.072222531 0.041086860 0.033717169 0.020731785
[15] 0.031202101 0.019251931 0.053952798 0.036710992 0.028892809 0.035885424 0.041058488
[22] 0.041872967 0.025273978 0.027822506 0.034040745 0.021281050 0.019424703 0.023771962
[29] 0.014919395 0.037401273 0.025749733 0.031581572 0.016034375 0.042423328 0.035818492
[36] 0.032631683 0.019308725 0.030957310 0.029712897 0.028792476 0.053254457 0.051756931
[43] 0.036608135 0.020655326 0.036543729 0.025240346 0.021245109 0.052809253 0.046869834
[50] 0.045300968 0.043458756 0.060351495 0.044650274 0.042656752 0.039788250 0.069518703
[57] 0.034383058 0.046911573 0.035384614 0.021227636 0.036432283 0.034215242 0.036599152
[64] 0.024024103 0.023039176 0.028786451 0.023340535 0.030069658 0.039331849 0.041158072
[71] 0.031046087 0.029471681 0.026317308 0.047940842 0.033615246 0.069253000 0.027180451
[78] 0.034322228 0.008339514 0.023258754 0.015404669 0.036890710 0.027560190 0.016210313
[85] 0.023117933 0.030771659 0.015511260 0.013688427 0.022965042 0.012616569 0.016900126
[92] 0.013074024 0.018786895 0.016369413 0.047548874 0.013394022 0.012696751 0.020946956
[99] 0.024328513 0.051093428 0.030819080 0.010844413 0.017864553 0.016754483 0.040934664
[106] 0.026947738 0.012477226 0.008060948 0.014116468 0.023155333 0.016562256 0.029320523
[113] 0.016282382 0.033180936 0.012132530 0.008828063 0.052028553 0.039452533 0.055616691
[120] 0.043032316 0.023931589 0.030553857 0.019843279 0.025585568 0.033371188 0.015928315
[127] 0.015797568 0.027577053 0.030743994 0.027080959 0.026046459 0.024013618 0.027807335
```

The first 10 lags of ACF of  $rt$ :





According to the Box-Ljung test shown below, the p-value  $< 2.2e-16$ . Therefore, we can reject the null hypothesis that the first 10 lags of ACF are zero. In other words, at least one of the first 10 ACFs is non-zero.

```
> Box.test(rt, lag=10, type="Ljung-Box")
```

Box-Ljung test

```
data: rt
```

```
X-squared = 5480.2, df = 10, p-value < 2.2e-16
```

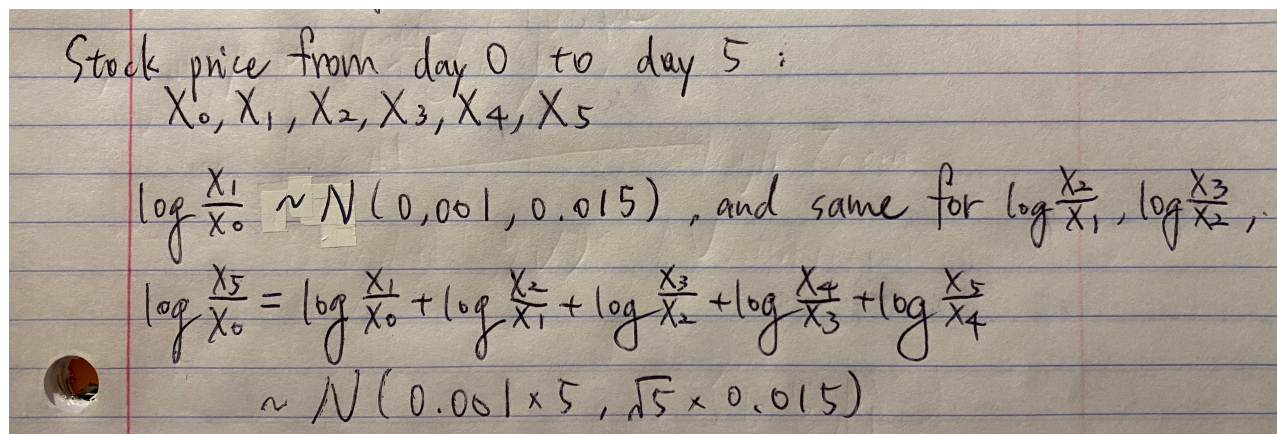
4.

(a) Probability that after one trading day my investment is worth less than \$990 = 0.2306557

```
> pnorm(log(990/1000), 0.001, 0.015)
[1] 0.2306557
```

(b) Probability that after five trading day my investment is worth less than \$990 = 0.3268189

```
> pnorm(log(990/1000), 0.001*5, 0.015*sqrt(5))
[1] 0.3268189
```



Stock price from day 0 to day 5:  
 $X_0, X_1, X_2, X_3, X_4, X_5$

$\log \frac{X_1}{X_0} \sim N(0.001, 0.015)$ , and same for  $\log \frac{X_2}{X_1}, \log \frac{X_3}{X_2}, \dots$

$$\log \frac{X_5}{X_0} = \log \frac{X_1}{X_0} + \log \frac{X_2}{X_1} + \log \frac{X_3}{X_2} + \log \frac{X_4}{X_3} + \log \frac{X_5}{X_4}$$
$$\sim N(0.001 \times 5, \sqrt{5} \times 0.015)$$