4997 code

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```
library(readxl)
library(dplyr)
BTC = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "BTC-USD")[, c("Date", "Log_Return")]
ETH = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "ETH-USD")[, c("Date", "Log_Return")]
USDT = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "USDT-USD")[, c("Date", "Log_Return")]
BNB = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "BNB-USD")[, c("Date", "Log_Return")]
XRP = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "XRP-USD")[, c("Date", "Log_Return")]
ADA = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "ADA-USD")[, c("Date", "Log_Return")]
LTC = read_excel("C:/Users/yu000/Desktop/Causality Analysis/Stat file/TOP5.xlsx",
    sheet = "LTC-USD")[, c("Date", "Log_Return")]
```

```
df = data.frame(BTC$Date, BTC$Log_Return, ETH$Log_Return, USDT$Log_Return, BNB$Log_Return,
    XRP$Log_Return, ADA$Log_Return, LTC$Log_Return)
df = df[2:2192, ]
colnames(df) = c("Date", "BTC", "ETH", "USDT", "BNB", "XRP", "ADA", "LTC")
```

```
library(psych)
library(dplyr)
summary_df = psych::describe(df[, -c(1)])
summary_df = as.data.frame(summary_df)[, c("mean", "sd", "min", "max", "skew", "kurtosis")]
```

Table1

```
library(tseries)
tt1 = tseries::jarque.bera.test(df$BTC)
tt2 = tseries::jarque.bera.test(df$ETH)
tt3 = tseries::jarque.bera.test(df$USDT)
tt4 = tseries::jarque.bera.test(df$BNB)
tt5 = tseries::jarque.bera.test(df$XRP)
tt6 = tseries::jarque.bera.test(df$ADA)
tt7 = tseries::jarque.bera.test(df$LTC)
summary_df$jbtest = c(tt1$statistic, tt2$statistic, tt3$statistic, tt4$statistic,
    tt5$statistic, tt6$statistic, tt7$statistic)
```

```
summary_df$jbpvalue = c(tt1$p.value, tt2$p.value, tt3$p.value, tt4$p.value, tt5$p.value,
    tt6$p.value, tt7$p.value)
t(summary_df)
```

```
##                    BTC           ETH          USDT           BNB           XRP
## mean      5.013923e-04  4.464911e-04 -2.016953e-06  1.624671e-03 -6.277571e-04
## sd        3.676888e-02  4.739021e-02  3.590978e-03  5.289690e-02  5.684107e-02
## min      -4.647302e-01 -5.507317e-01 -5.256970e-02 -5.430840e-01 -5.505025e-01
## max       1.718206e-01  2.306952e-01  5.339335e-02  5.292179e-01  5.485549e-01
## skew     -1.063515e+00 -1.033042e+00  3.600314e-01  2.806693e-01  3.251039e-01
## kurtosis  1.429637e+01  1.132602e+01  5.151476e+01  1.898534e+01  1.686493e+01
## jbtest    1.911363e+04  1.212809e+04  2.427831e+05  3.300392e+04  2.606028e+04
## jbpvalue  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
##                   ADA           LTC
## mean     -1.149549e-04 -5.716868e-04
## sd        5.556017e-02  5.036770e-02
## min      -5.036382e-01 -4.490616e-01
## max       3.217964e-01  2.905937e-01
## skew     -2.362453e-02 -5.499003e-01
## kurtosis  6.024482e+00  8.302385e+00
## jbtest    3.322652e+03  6.418933e+03
## jbpvalue  0.000000e+00  0.000000e+00
```

Table2

```
library(tseries)
variables <- c("BTC", "ETH", "USDT", "BNB", "XRP", "ADA", "LTC")
adf_results <- lapply(df[variables], adf.test)
adf_df <- data.frame(variable = variables, statistic = sapply(adf_results, function(x) x$statistic),
    pct1level = -3.436111, pct5level = -2.863972, pct10level = -2.568116, Results = ifelse(sapply(adf_r
        function(x) x$p.value) < 0.05, "stationary", "non-stationary"))
adf_df
```

```
##                     variable statistic pct1level pct5level pct10level    Results
## BTC.Dickey-Fuller        BTC -12.53171 -3.436111 -2.863972  -2.568116 stationary
## ETH.Dickey-Fuller        ETH -12.23892 -3.436111 -2.863972  -2.568116 stationary
## USDT.Dickey-Fuller      USDT -16.15378 -3.436111 -2.863972  -2.568116 stationary
## BNB.Dickey-Fuller        BNB -12.02447 -3.436111 -2.863972  -2.568116 stationary
## XRP.Dickey-Fuller        XRP -13.19189 -3.436111 -2.863972  -2.568116 stationary
## ADA.Dickey-Fuller        ADA -11.83000 -3.436111 -2.863972  -2.568116 stationary
## LTC.Dickey-Fuller        LTC -13.11165 -3.436111 -2.863972  -2.568116 stationary
```

Figure 1

```
library(lubridate)
library(dplyr)
library(zoo)
df1=df
```

```r
df1$month=as.yearqtr(df1$Date,            # Convert dates to quarterly
                     format = "%Y-%m-%d")
df_plot=df1%>%group_by(month)%>%summarise(BTC=sum(BTC),
                                          ETH=sum(ETH),
                                         USDT=sum(USDT),
                                         BNB=sum(BNB),
                                         XRP=sum(XRP),
                                         ADA=sum(ADA),
                                         LTC=sum(LTC),)
```

```r
library(ggplot2)
ggplot(df_plot, aes(x = month)) + geom_line(aes(y = BTC, col = "BTC")) + geom_line(aes(y = ETH,
    col = "ETH")) + geom_line(aes(y = USDT, col = "USDT")) + geom_line(aes(y = BNB,
    col = "BNB")) + geom_line(aes(y = XRP, col = "XRP")) + geom_line(aes(y = ADA,
    col = "ADA")) + geom_line(aes(y = LTC, col = "LTC")) + labs(col = "", x = "Date",
    y = "Quarterly Returns") + scale_y_continuous(labels = scales::percent)
```

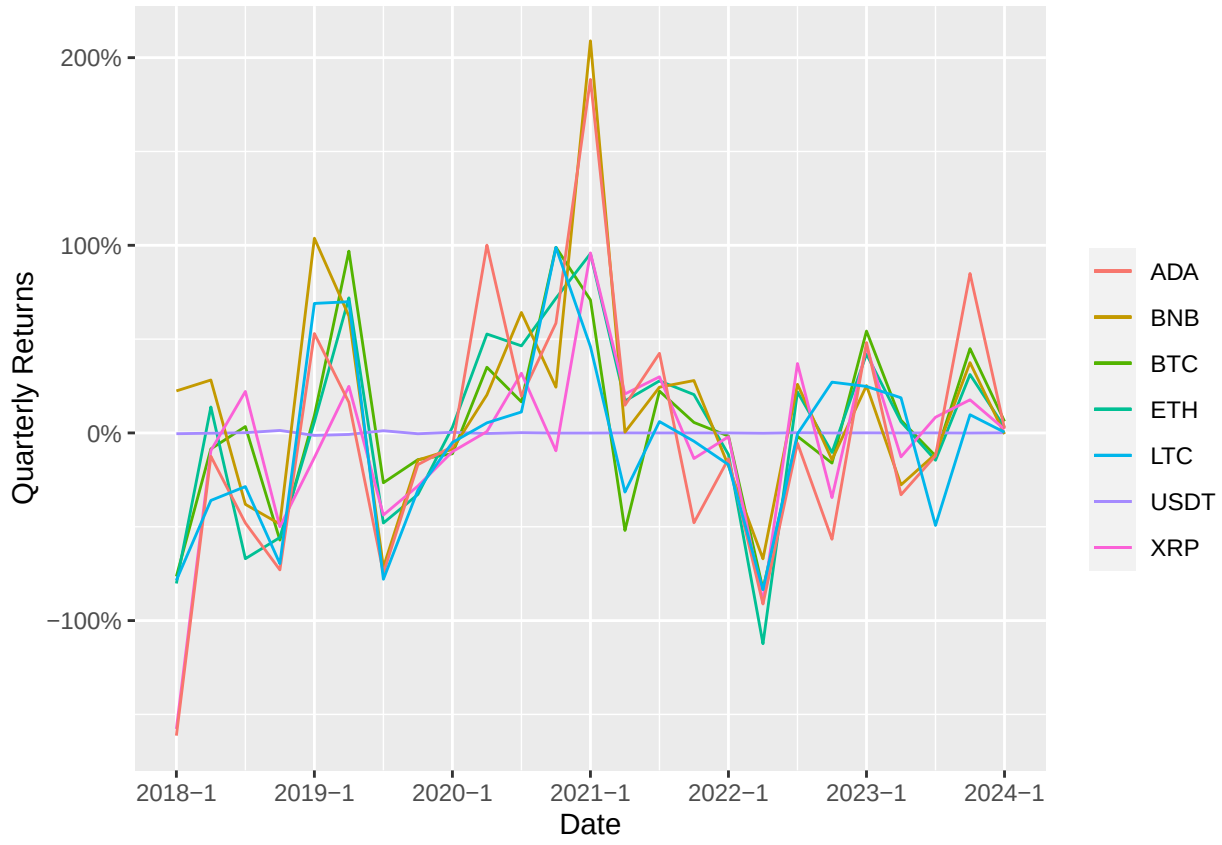

Figure 2

```r
library(corrplot)
M = cor(df[-c(1)])
M
```

```
##              BTC         ETH        USDT         BNB         XRP         ADA
## BTC    1.0000000  0.83070431 -0.02447900  0.67536590  0.62159225  0.70969816
## ETH    0.8307043  1.00000000 -0.05772059  0.68600278  0.67325536  0.76736002
## USDT -0.0244790 -0.05772059  1.00000000 -0.04410447 -0.05090172 -0.04316323
## BNB    0.6753659  0.68600278 -0.04410447  1.00000000  0.54903194  0.60599679
## XRP    0.6215922  0.67325536 -0.05090172  0.54903194  1.00000000  0.67124097
## ADA    0.7096982  0.76736002 -0.04316323  0.60599679  0.67124097  1.00000000
## LTC    0.7968476  0.82169335 -0.03969825  0.67071086  0.67118434  0.73312598
##              LTC
## BTC    0.79684762
## ETH    0.82169335
## USDT -0.03969825
## BNB    0.67071086
## XRP    0.67118434
## ADA    0.73312598
## LTC    1.00000000
```

```
corrplot.mixed(M, order = "AOE")
```

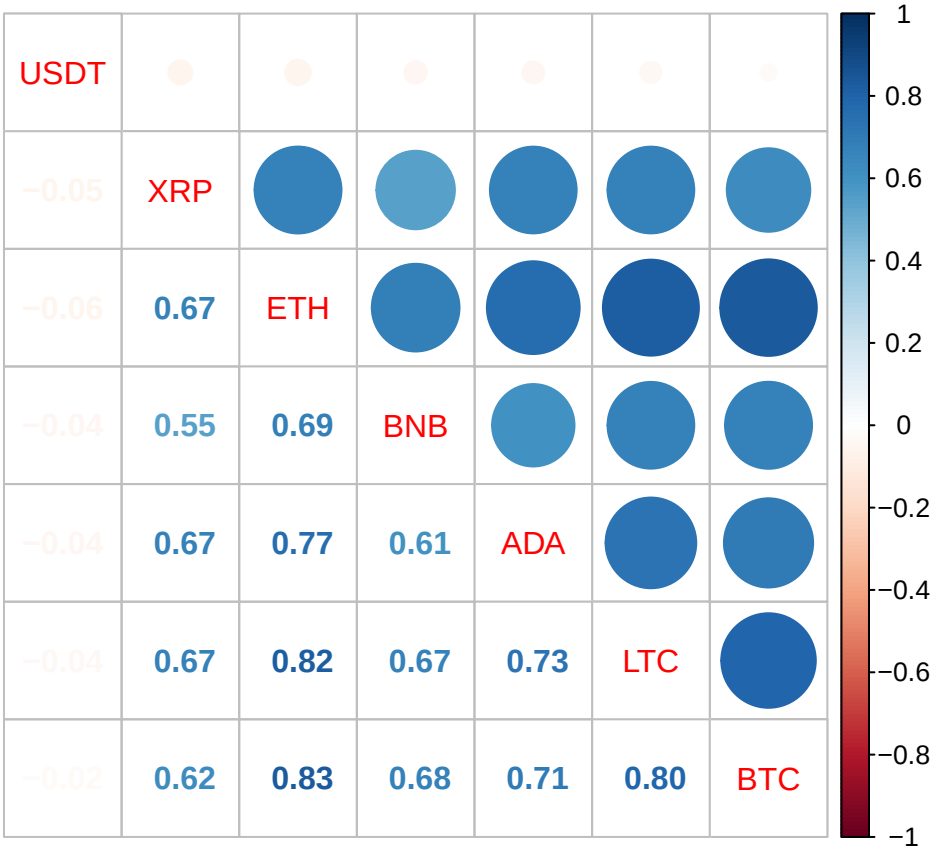

Table3

```
library(lmtest)
library(dplyr)
```

```
res_df <- c()
for (m in 2:8) {
    for (n in 2:8) {
        if (m != n) {
            dd = grangertest(df[, c(m)] ~ df[, c(n)])
            res_df <- rbind(res_df, c(colnames(df)[m], colnames(df)[n], dd$F, dd$`Pr(>F)`,
                ifelse(dd$`Pr(>F)` < 0.01, "Fail to Reject", "Reject")))
        }
    }
}
res_df <- as.data.frame(res_df[, c(1, 2, 4, 6, 8)])
res_df$Null_Hypothesis <- paste(res_df[, 1], "is not a Granger cause of changes in",
    res_df[, 2])

res_df %>%
    select(Null_Hypothesis, F_Statistic = V3, Probability = V4, Test_Result = V5)
```

```
##                                 Null_Hypothesis         F_Statistic
## 1   BTC is not a Granger cause of changes in ETH    4.22887920857544
## 2  BTC is not a Granger cause of changes in USDT    1.73388889926585
## 3   BTC is not a Granger cause of changes in BNB    3.11692250469318
## 4   BTC is not a Granger cause of changes in XRP    3.63955675785136
## 5   BTC is not a Granger cause of changes in ADA  0.0341801129508348
## 6   BTC is not a Granger cause of changes in LTC    1.08675080805586
## 7   ETH is not a Granger cause of changes in BTC    1.41686558645452
## 8  ETH is not a Granger cause of changes in USDT     4.6181317513628
## 9   ETH is not a Granger cause of changes in BNB    1.01698612234919
## 10  ETH is not a Granger cause of changes in XRP    4.50647099041566
## 11  ETH is not a Granger cause of changes in ADA  0.0091764662835977
## 12  ETH is not a Granger cause of changes in LTC   0.370182319267367
## 13 USDT is not a Granger cause of changes in BTC   0.237785751769047
## 14 USDT is not a Granger cause of changes in ETH   0.453678240356877
## 15 USDT is not a Granger cause of changes in BNB    2.43788481424506
## 16 USDT is not a Granger cause of changes in XRP   0.325079019762131
## 17 USDT is not a Granger cause of changes in ADA 0.00289942880113161
## 18 USDT is not a Granger cause of changes in LTC    0.46269251710596
## 19  BNB is not a Granger cause of changes in BTC    3.33401222535389
## 20  BNB is not a Granger cause of changes in ETH    5.32604031513693
## 21 BNB is not a Granger cause of changes in USDT   0.606186219063668
## 22  BNB is not a Granger cause of changes in XRP      7.680664933979
## 23  BNB is not a Granger cause of changes in ADA    5.23427956402419
## 24  BNB is not a Granger cause of changes in LTC    5.79625421190609
## 25  XRP is not a Granger cause of changes in BTC    5.34469220408571
## 26  XRP is not a Granger cause of changes in ETH    11.1043200750247
## 27 XRP is not a Granger cause of changes in USDT    3.06462336736748
## 28  XRP is not a Granger cause of changes in BNB    2.77504489710051
## 29  XRP is not a Granger cause of changes in ADA    2.35011074694441
## 30  XRP is not a Granger cause of changes in LTC     8.8282715089708
## 31  ADA is not a Granger cause of changes in BTC    8.51275883415948
## 32  ADA is not a Granger cause of changes in ETH    8.45498066910508
## 33 ADA is not a Granger cause of changes in USDT    5.44570980690017
## 34  ADA is not a Granger cause of changes in BNB  0.0658186867127157
## 35  ADA is not a Granger cause of changes in XRP    3.70014318492106
```

```
## 36  ADA is not a Granger cause of changes in LTC    6.49620207964654
## 37  LTC is not a Granger cause of changes in BTC      2.114247183056
## 38  LTC is not a Granger cause of changes in ETH     9.4687087828077
## 39 LTC is not a Granger cause of changes in USDT    4.63892395849623
## 40  LTC is not a Granger cause of changes in BNB    1.05212397477169
## 41  LTC is not a Granger cause of changes in XRP    4.22556794600391
## 42  LTC is not a Granger cause of changes in ADA    2.44243578843945
##             Probability    Test_Result
## 1     0.039860084912982         Reject
## 2     0.188052972964187         Reject
## 3    0.0776225144656343         Reject
## 4    0.0565528014032685         Reject
## 5       0.8533413641701         Reject
## 6     0.297307468454569         Reject
## 7     0.234049191072546         Reject
## 8    0.0317451278238182         Reject
## 9     0.313346537039571         Reject
## 10    0.033878891598734         Reject
## 11     0.92369305931849         Reject
## 12    0.542968088149231         Reject
## 13    0.625858832446373         Reject
## 14     0.50066454669074         Reject
## 15    0.118580514210375         Reject
## 16    0.568629774712266         Reject
## 17    0.957062503613559         Reject
## 18    0.496440301066823         Reject
## 19   0.0679974309879834         Reject
## 20   0.0211019869684217         Reject
## 21    0.436311618498535         Reject
## 22  0.00562879977774304 Fail to Reject
## 23   0.0222410202203473         Reject
## 24   0.0161426953919368         Reject
## 25   0.0208779471626707         Reject
## 26 0.000875610906326686 Fail to Reject
## 27   0.0801539097513574         Reject
## 28   0.0958871840363831         Reject
## 29    0.125418744081554         Reject
## 30  0.00299832501853272 Fail to Reject
## 31  0.00356262299052211 Fail to Reject
## 32  0.00367712701581646 Fail to Reject
## 33   0.0197066254790747         Reject
## 34    0.797549128231362         Reject
## 35   0.0545374679309749         Reject
## 36    0.010878299267877         Reject
## 37    0.146077287867868         Reject
## 38  0.00211597275209223 Fail to Reject
## 39    0.031363558399015         Reject
## 40     0.30513185937149         Reject
## 41   0.0399377745775534         Reject
## 42    0.118237402932817         Reject
```

Table4

```
write.csv(df, "C:/Users/yu000/Desktop/Causality Analysis/Stat file/matlab/return.csv")
```

```
info = read.csv("C:/Users/yu000/Desktop/Causality Analysis/Stat file/matlab/res_info.csv")
info$INFO = round(info$INFO, 3)
info$err90l = round(info$err90l, 3)
info$value = paste(info$INFO, "$\\pm$", info$err90l)
```

```
library(reshape2)
info$flag = ifelse(info$INFO + info$err90l > 0, "N", "Y")
final_table = info[c(1, 2, 8)] %>%
    dcast(T2 ~ T1)
knitr::kable(final_table)
```

T2	ADA	BNB	BTC	ETH	LTC	USDT	XRP
ADA	NA	Y	N	N	N	N	N
BNB	N	NA	Y	N	N	Y	Y
BTC	Y	Y	NA	N	N	N	Y
ETH	Y	Y	Y	NA	Y	N	Y
LTC	Y	Y	N	N	NA	Y	Y
USDT	Y	N	Y	Y	Y	NA	Y
XRP	Y	Y	Y	Y	Y	N	NA

```
final_table = info[c(1, 2, 7)] %>%
    dcast(T2 ~ T1)
knitr::kable(final_table)
```

T2	ADA	BNB	BTC	ETH	LTC	USDT	XRP
ADA	NA	-0.037 ± 0.027	-0.004 ± 0.035	-0.002 ± 0.042	-0.036 ± 0.038	0 ± 0.001	-0.03 ± 0.032
BNB	-0.004 ± 0.027	NA	-0.035 ± 0.032	-0.02 ± 0.033	-0.02 ± 0.032	-0.001 ± 0.001	-0.023 ± 0.023
BTC	-0.062 ± 0.035	-0.036 ± 0.032	NA	-0.038 ± 0.052	-0.041 ± 0.046	0 ± 0.001	-0.039 ± 0.028
ETH	-0.074 ± 0.042	-0.046 ± 0.033	-0.065 ± 0.053	NA	-0.095 ± 0.051	-0.001 ± 0.002	-0.064 ± 0.032
LTC	-0.058 ± 0.038	-0.046 ± 0.032	-0.029 ± 0.046	-0.019 ± 0.051	NA	-0.001 ± 0.001	-0.057 ± 0.032
USDT	-0.002 ± 0.002	0.001 ± 0.002	-0.001 ± 0.001	-0.003 ± 0.002	-0.002 ± 0.001	NA	-0.002 ± 0.002
XRP	-0.037 ± 0.032	-0.039 ± 0.023	-0.032 ± 0.028	-0.041 ± 0.032	-0.04 ± 0.032	0.001 ± 0.002	NA