```
# Final Presentation Code
# Section 1: Introduction
# Sec 2: Literature Review
# Sec 3: Data
# Sec 4: Empirical Methodology
# Sec 5: Results
# Sec 6: Conclusion
# Sec 7: Bibliography
# Sec 8: Appendix

library(quantmod)
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: TTR
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library(dplyr)
```

```
##
## ######################### Warning from 'xts' package ##########################
## #                                                                             #
## # The dplyr lag() function breaks how base R's lag() function is supposed to  #
## # work, which breaks lag(my_xts). Calls to lag(my_xts) that you type or       #
## # source() into this session won't work correctly.                            #
## #                                                                             #
## # Use stats::lag() to make sure you're not using dplyr::lag(), or you can add #
## # conflictRules('dplyr', exclude = 'lag') to your .Rprofile to stop           #
## # dplyr from breaking base R's lag() function.                                #
## #                                                                             #
## # Code in packages is not affected. It's protected by R's namespace mechanism #
## # Set `options(xts.warn_dplyr_breaks_lag = FALSE)` to suppress this warning.  #
## #                                                                             #
## ###############################################################################
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:xts':
##
##     first, last
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(plotly)
```

```
##
## Attaching package: 'plotly'
```

```
## The following object is masked from 'package:ggplot2':
##
##     last_plot
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following object is masked from 'package:graphics':
##
##     layout
```

```
library(zoo)
library(xts)
library(stats)
library(gtrendsR)
library(quantmod)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library(gapminder)
library(ROCR)
library(corrplot)
```

```
## corrplot 0.95 loaded
```

```
library(languageserver)
library(lubridate)
library(forecast)
library(TTR)
library(vars)
```

```
## Loading required package: MASS
```

```
##
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:plotly':
##
##     select
```

```
## The following object is masked from 'package:dplyr':
##
##     select
```

```
## Loading required package: strucchange
```

```
## Loading required package: sandwich
```

```
## Loading required package: urca
```

```
## Loading required package: lmtest
```

```
library(tseries)
library(randomForest)
```

```
## randomForest 4.7-1.2
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin
```

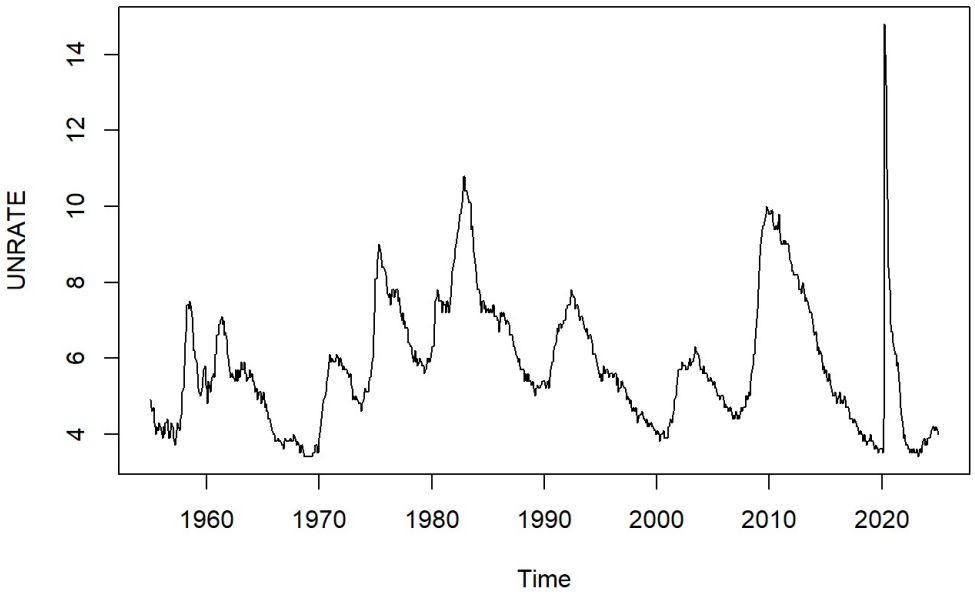
```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
rm(list=ls())
source("https://bigblue.depaul.edu/jlee141/econdata/R/func_tslib.R")


getSymbols("UNRATE", src = "FRED", from ="1955-01-01")        # Unemployment rate
```

```
## [1] "UNRATE"
```

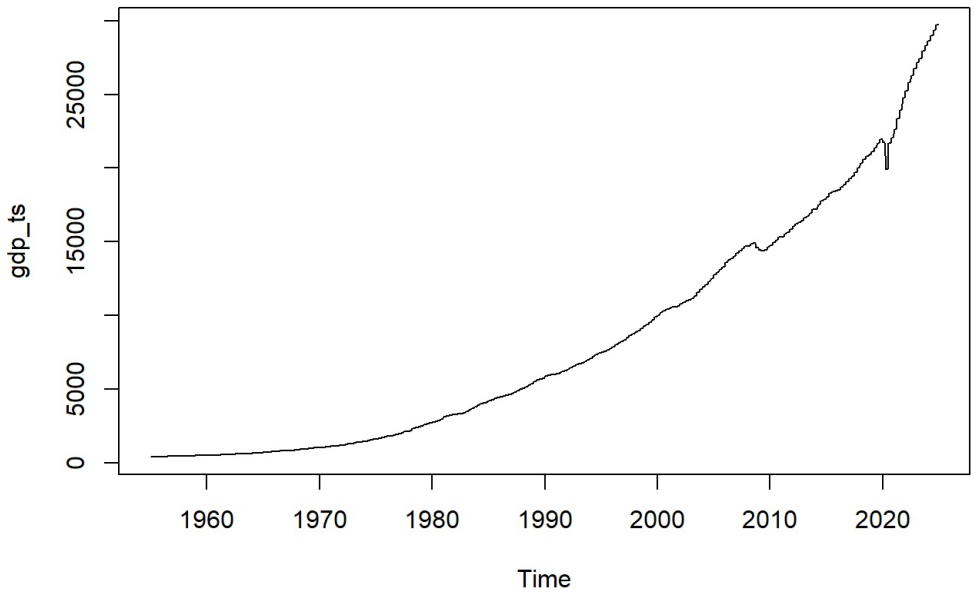
```
unrate_ts <- ts(coredata(UNRATE$UNRATE), start = c(1955,1), frequency = 12)
plot(unrate_ts)
```




```
getSymbols("GDP", src = "FRED", from = "1955-01-01")          # GDP Data
```

```
## [1] "GDP"
```

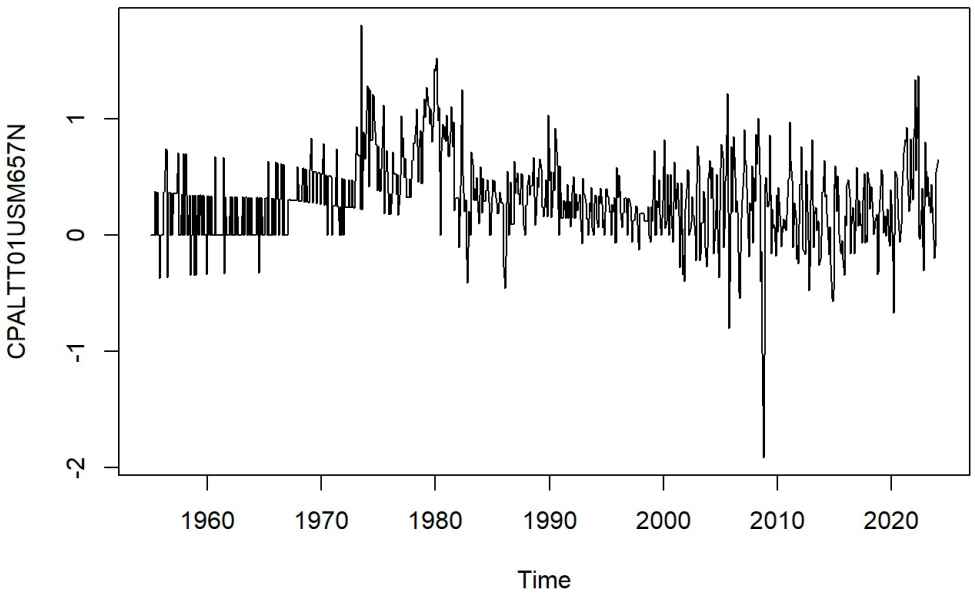
```
expanded_gdp <- rep(GDP, each = 3)                            # Expanded quarterly GDP to data to monthly
gdp_ts <- ts(coredata(expanded_gdp), start = c(1955,1), frequency = 12)
plot(gdp_ts)
```




```
getSymbols("CPALTT01USM657N", src = "FRED", from = "1955-01-01")        # Consumer Index
```

```
## [1] "CPALTT01USM657N"
```

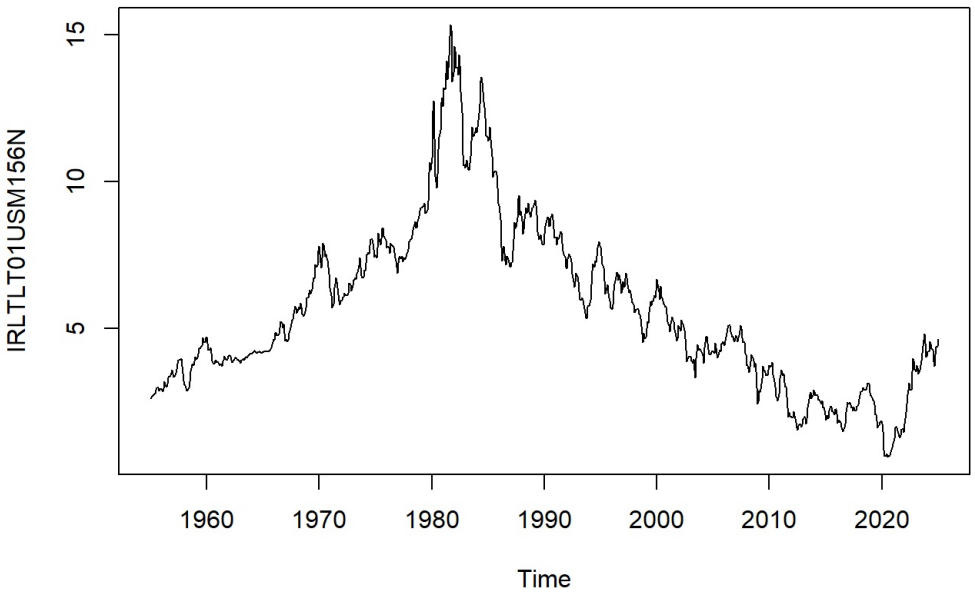
```
consumer_ts <- ts(coredata(CPALTT01USM657N), start = c(1955,1), frequency = 12)
plot(consumer_ts)
```



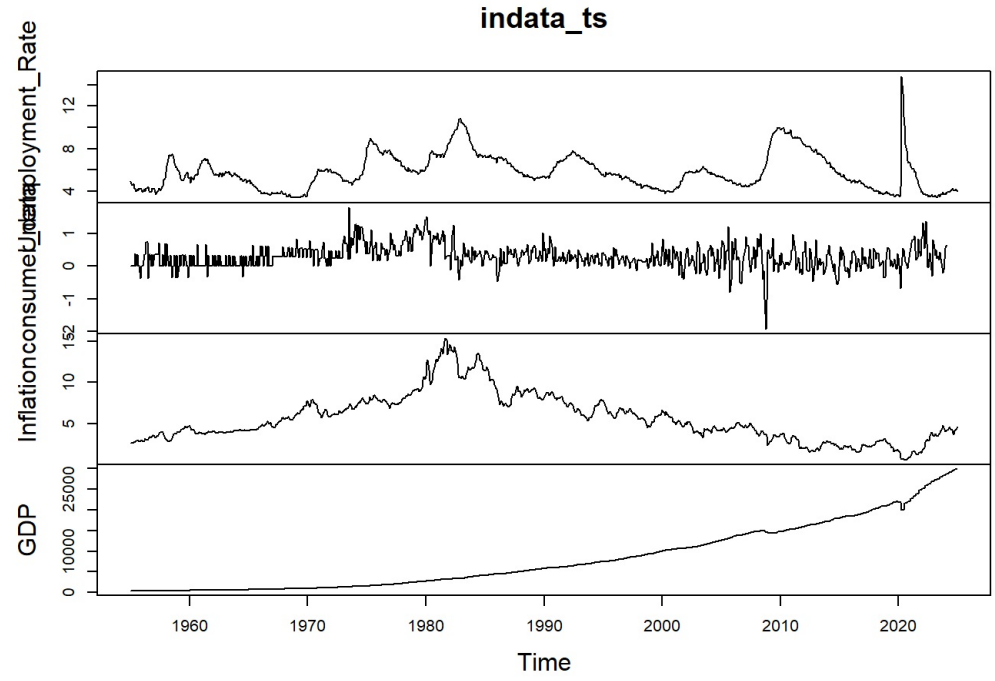

```
getSymbols("IRLTLT01USM156N", src = "FRED", from = "1955-01-01")        # Inflation Index
```

```
## [1] "IRLTLT01USM156N"
```

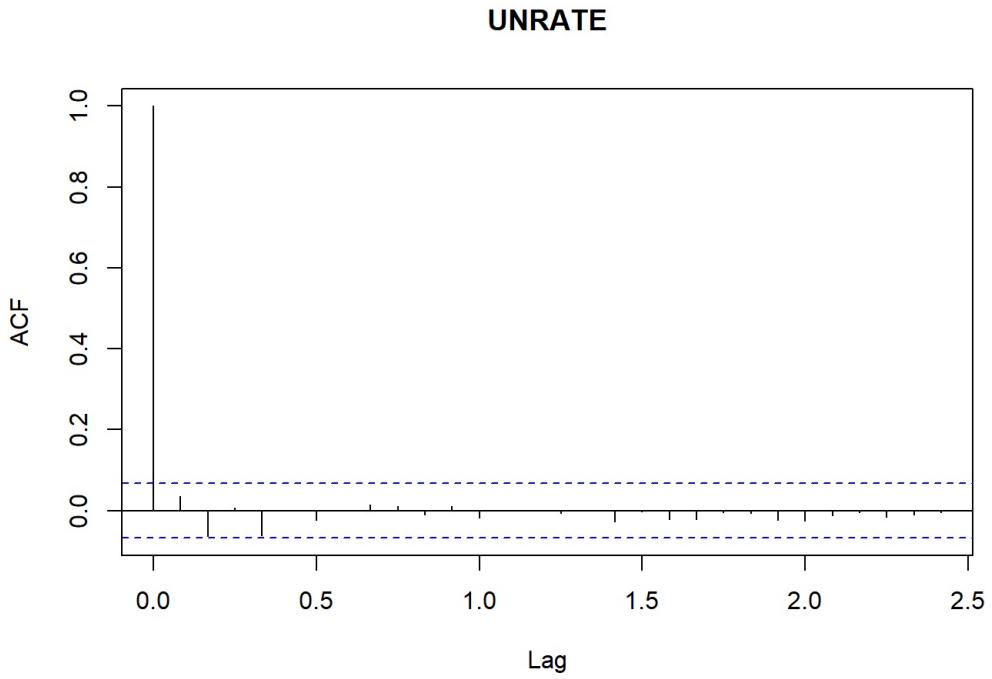
```
inflation_ts <- ts(coredata(IRLTLT01USM156N), start = c(1955,1), frequency = 12)
plot(inflation_ts)
```



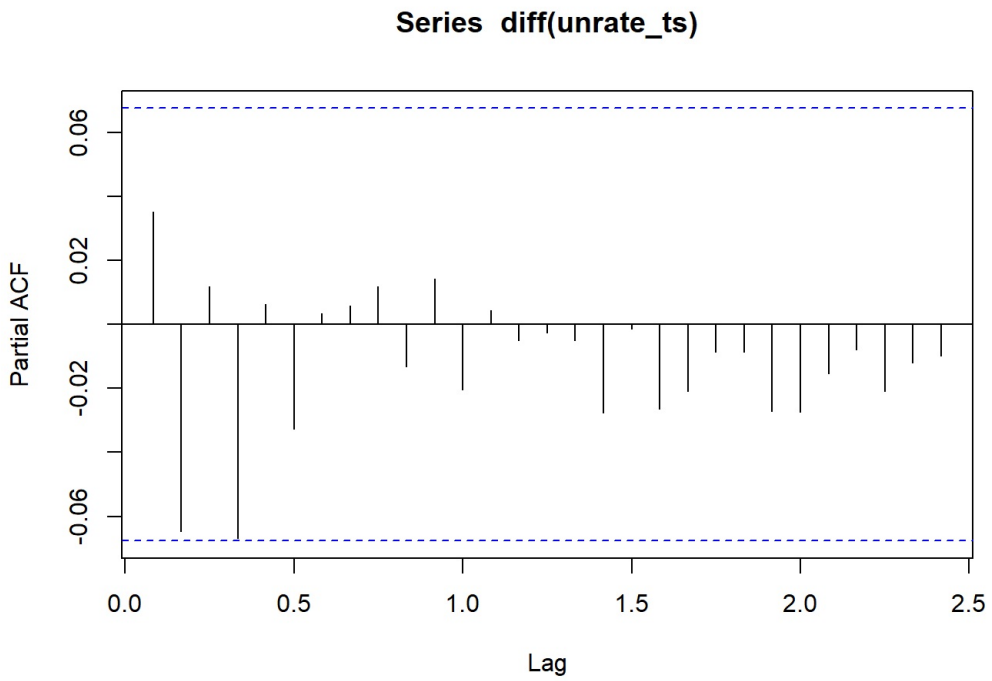

```
# Combine Data from data frame
indata_ts <- ts(cbind(unrate_ts,consumer_ts,inflation_ts,gdp_ts), start=c(1955,1), frequency = 12)
colnames(indata_ts) <- c("Unemployment_Rate","consumer_data", "Inflation","GDP" )
plot(indata_ts)
```




```
acf(diff(unrate_ts))
```




```
pacf(diff(unrate_ts))
```




```
indata_ts <- na.omit(indata_ts)

#Train & Test Data
indata_train <- window(indata_ts, end=c(2017,12))
indata_test <- window(indata_ts, start=c(2018,1))
indata_test_y <- indata_test[,1]

# VAR Model Lag Selection
var_lag_selection <- VARselect(indata_train, lag.max = 16, type = "both")
var_lag_selection
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##     13      4      4     13
##
## $criteria
##                 1          2          3          4         5          6
## AIC(n) -0.4514047 -0.6909814 -1.1791545 -1.7837172 -1.796018 -1.8051150
## HQ(n)  -0.3937997 -0.5949731 -1.0447429 -1.6109023 -1.584800 -1.5554934
## SC(n)  -0.3019998 -0.4419733 -0.8305431 -1.3355026 -1.248200 -1.1576939
## FPE(n)  0.6367340  0.5010874  0.3075442  0.1680189  0.165970  0.1644746
##                 7          8          9         10         11         12
## AIC(n) -1.8631854 -1.8361232 -1.8320773 -1.8595167 -1.9080887 -1.9593538
## HQ(n)  -1.5751605 -1.5096950 -1.4672458 -1.4562819 -1.4664506 -1.4793123
## SC(n)  -1.1161611 -0.9894956 -0.8858465 -0.8136826 -0.7626514 -0.7143132
## FPE(n)  0.1552051  0.1594756  0.1601386  0.1558240  0.1484590  0.1410658
##                13         14         15         16
## AIC(n) -1.9655107 -1.9342266 -1.9274579 -1.9233808
## HQ(n)  -1.4470659 -1.3773785 -1.3322065 -1.2897260
## SC(n)  -0.6208669 -0.4899795 -0.3836076 -0.2799272
## FPE(n)  0.1402300  0.1447224  0.1457470  0.1463902
```

```
optimal_lag <- var_lag_selection$selection["AIC(n)"]
var_model <- VAR(indata_train, p = optimal_lag, type = "both")
var_forecast <- forecast(var_model, h=3)
summary(var_model)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: Unemployment_Rate, consumer_data, Inflation, GDP
## Deterministic variables: both
## Sample size: 743
## Log Likelihood: -3267.177
## Roots of the characteristic polynomial:
## 0.9999 0.9909 0.9909 0.972 0.972 0.9288 0.9288 0.9284 0.9284 0.9245 0.9245 0.9094 0.9094 0.9005 0.9005 0.8824
0.8824 0.8795 0.8795 0.865 0.865 0.8617 0.8617 0.8547 0.8547 0.8465 0.8465 0.8412 0.8412 0.8358 0.8358 0.8354 0.8
354 0.8343 0.8289 0.8289 0.8234 0.8234 0.8116 0.7886 0.7886 0.7848 0.7848 0.723 0.723 0.6839 0.6698 0.6698 0.6555
0.6555 0.4418 0.4418
## Call:
## VAR(y = indata_train, p = optimal_lag, type = "both")
##
##
## Estimation results for equation Unemployment_Rate:
## ==================================================
## Unemployment_Rate = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + c
onsumer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemp
loyment_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.
l5 + GDP.l5 + Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_d
ata.l7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8 + Inflation.l8 + GDP.l8 + Unemployment_R
ate.l9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + G
DP.l10 + Unemployment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_d
ata.l12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l13 + Inflation.l13 + GDP.l13 + const +
trend
##
##                         Estimate Std. Error t value Pr(>|t|)
## Unemployment_Rate.l1   9.317e-01  3.867e-02  24.093  < 2e-16 ***
## consumer_data.l1       1.005e-03  2.410e-02   0.042 0.966755
## Inflation.l1          -7.282e-02  2.664e-02  -2.734 0.006426 **
## GDP.l1                -5.745e-04  2.090e-04  -2.749 0.006140 **
## Unemployment_Rate.l2   1.626e-01  5.246e-02   3.099 0.002022 **
## consumer_data.l2       3.242e-02  2.475e-02   1.310 0.190612
## Inflation.l2           5.536e-02  4.376e-02   1.265 0.206276
## GDP.l2                 9.803e-05  2.803e-04   0.350 0.726603
## Unemployment_Rate.l3  -3.778e-02  5.263e-02  -0.718 0.473080
## consumer_data.l3       5.652e-03  2.453e-02   0.230 0.817837
## Inflation.l3           1.308e-02  4.630e-02   0.282 0.777694
## GDP.l3                 3.136e-04  2.816e-04   1.114 0.265725
## Unemployment_Rate.l4   3.491e-02  5.261e-02   0.664 0.507179
## consumer_data.l4       1.414e-02  2.457e-02   0.575 0.565206
## Inflation.l4           1.895e-02  4.707e-02   0.403 0.687400
## GDP.l4                -1.750e-04  2.993e-04  -0.585 0.559012
## Unemployment_Rate.l5  -2.159e-02  5.268e-02  -0.410 0.682110
## consumer_data.l5       3.132e-02  2.456e-02   1.275 0.202673
## Inflation.l5           7.354e-03  4.693e-02   0.157 0.875535
## GDP.l5                -5.001e-06  3.126e-04  -0.016 0.987241
## Unemployment_Rate.l6  -4.639e-02  5.278e-02  -0.879 0.379716
## consumer_data.l6      -1.432e-02  2.452e-02  -0.584 0.559307
```

```
## Inflation.l6           2.125e-02  4.685e-02   0.454 0.650294
## GDP.l6                -2.091e-04  3.125e-04  -0.669 0.503583
## Unemployment_Rate.l7  -5.518e-02  5.271e-02  -1.047 0.295563
## consumer_data.l7       1.344e-02  2.452e-02   0.548 0.583723
## Inflation.l7          -3.478e-02  4.700e-02  -0.740 0.459525
## GDP.l7                 4.954e-04  3.140e-04   1.578 0.115052
## Unemployment_Rate.l8   2.664e-03  5.273e-02   0.051 0.959721
## consumer_data.l8      -1.420e-02  2.451e-02  -0.579 0.562555
## Inflation.l8          -1.588e-02  4.683e-02  -0.339 0.734577
## GDP.l8                 2.034e-04  3.131e-04   0.649 0.516233
## Unemployment_Rate.l9  -9.684e-03  5.263e-02  -0.184 0.854074
## consumer_data.l9       2.973e-02  2.451e-02   1.213 0.225639
## Inflation.l9           5.174e-02  4.668e-02   1.108 0.268044
## GDP.l9                -3.118e-04  3.181e-04  -0.980 0.327224
## Unemployment_Rate.l10 -3.820e-02  5.261e-02  -0.726 0.467964
## consumer_data.l10      2.008e-02  2.435e-02   0.825 0.409821
## Inflation.l10         -9.001e-02  4.670e-02  -1.927 0.054353 .
## GDP.l10                1.591e-04  3.066e-04   0.519 0.604087
## Unemployment_Rate.l11  9.992e-02  5.236e-02   1.908 0.056761 .
## consumer_data.l11      2.844e-02  2.421e-02   1.174 0.240605
## Inflation.l11          6.231e-02  4.587e-02   1.358 0.174770
## GDP.l11               -3.494e-04  2.925e-04  -1.194 0.232697
## Unemployment_Rate.l12 -1.794e-01  5.221e-02  -3.436 0.000626 ***
## consumer_data.l12      1.849e-02  2.443e-02   0.757 0.449280
## Inflation.l12         -2.041e-02  4.304e-02  -0.474 0.635465
## GDP.l12                2.473e-04  2.954e-04   0.837 0.402808
## Unemployment_Rate.l13  1.339e-01  3.703e-02   3.616 0.000321 ***
## consumer_data.l13      1.552e-02  2.412e-02   0.644 0.520032
## Inflation.l13          1.531e-02  2.628e-02   0.583 0.560260
## GDP.l13                1.319e-04  2.213e-04   0.596 0.551354
## const                  5.662e-02  2.859e-02   1.980 0.048080 *
## trend                 -3.010e-04  1.785e-04  -1.686 0.092210 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.1672 on 689 degrees of freedom
## Multiple R-Squared: 0.9895,  Adjusted R-squared: 0.9887
## F-statistic:  1226 on 53 and 689 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation consumer_data:
## ==============================================
## consumer_data = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consu
mer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemploym
ent_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 +
GDP.l5 + Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l
7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8 + Inflation.l8 + GDP.l8 + Unemployment_Rate.l
9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l1
0 + Unemployment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l
12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l13 + Inflation.l13 + GDP.l13 + const + tren
d
##
##                          Estimate Std. Error t value Pr(>|t|)
## Unemployment_Rate.l1  -9.338e-02  6.187e-02  -1.509 0.131689
## consumer_data.l1       3.178e-01  3.855e-02   8.244 8.43e-16 ***
## Inflation.l1           6.522e-02  4.262e-02   1.530 0.126403
## GDP.l1                 1.861e-04  3.344e-04   0.557 0.578032
## Unemployment_Rate.l2  -9.057e-02  8.393e-02  -1.079 0.280906
## consumer_data.l2       8.734e-02  3.960e-02   2.206 0.027739 *
## Inflation.l2          -5.705e-02  7.001e-02  -0.815 0.415447
## GDP.l2                -5.899e-04  4.484e-04  -1.316 0.188733
## Unemployment_Rate.l3   1.229e-01  8.421e-02   1.460 0.144877
## consumer_data.l3      -5.131e-02  3.925e-02  -1.307 0.191544
## Inflation.l3          -1.182e-03  7.407e-02  -0.016 0.987276
## GDP.l3                -1.722e-04  4.505e-04  -0.382 0.702375
## Unemployment_Rate.l4  -6.595e-02  8.417e-02  -0.784 0.433534
## consumer_data.l4       7.675e-02  3.931e-02   1.953 0.051279 .
## Inflation.l4          -2.253e-02  7.530e-02  -0.299 0.764879
## GDP.l4                 5.333e-04  4.788e-04   1.114 0.265789
## Unemployment_Rate.l5   1.094e-01  8.428e-02   1.298 0.194628
## consumer_data.l5      -4.617e-03  3.930e-02  -0.117 0.906505
## Inflation.l5          -4.307e-02  7.509e-02  -0.574 0.566421
## GDP.l5                 2.666e-05  5.002e-04   0.053 0.957515
## Unemployment_Rate.l6   9.474e-02  8.445e-02   1.122 0.262323
## consumer_data.l6       2.378e-02  3.923e-02   0.606 0.544489
## Inflation.l6           2.895e-02  7.496e-02   0.386 0.699398
## GDP.l6                -2.905e-04  4.999e-04  -0.581 0.561433
## Unemployment_Rate.l7  -5.058e-02  8.433e-02  -0.600 0.548849
```

```
## consumer_data.l7       7.711e-02  3.923e-02   1.966 0.049741 *
## Inflation.l7           6.385e-02  7.519e-02   0.849 0.396073
## GDP.l7                -9.779e-04  5.023e-04  -1.947 0.051961 .
## Unemployment_Rate.l8   6.242e-02  8.436e-02   0.740 0.459593
## consumer_data.l8      -2.883e-02  3.922e-02  -0.735 0.462466
## Inflation.l8           7.889e-03  7.493e-02   0.105 0.916176
## GDP.l8                 1.842e-03  5.009e-04   3.678 0.000254 ***
## Unemployment_Rate.l9  -1.469e-01  8.421e-02  -1.744 0.081630 .
## consumer_data.l9       2.221e-02  3.922e-02   0.566 0.571458
## Inflation.l9           1.429e-02  7.468e-02   0.191 0.848267
## GDP.l9                 8.899e-05  5.089e-04   0.175 0.861232
## Unemployment_Rate.l10 -1.321e-01  8.417e-02  -1.570 0.116975
## consumer_data.l10      3.965e-02  3.896e-02   1.018 0.309111
## Inflation.l10         -9.904e-02  7.472e-02  -1.325 0.185459
## GDP.l10               -2.227e-04  4.906e-04  -0.454 0.650076
## Unemployment_Rate.l11  1.700e-01  8.377e-02   2.030 0.042767 *
## consumer_data.l11      1.385e-01  3.874e-02   3.576 0.000373 ***
## Inflation.l11          3.112e-02  7.339e-02   0.424 0.671666
## GDP.l11               -1.291e-03  4.681e-04  -2.758 0.005970 **
## Unemployment_Rate.l12 -1.234e-01  8.354e-02  -1.477 0.140009
## consumer_data.l12      2.205e-01  3.908e-02   5.642 2.45e-08 ***
## Inflation.l12         -5.410e-02  6.886e-02  -0.786 0.432315
## GDP.l12               -4.057e-05  4.727e-04  -0.086 0.931625
## Unemployment_Rate.l13  1.334e-01  5.925e-02   2.251 0.024704 *
## consumer_data.l13      4.023e-03  3.858e-02   0.104 0.916980
## Inflation.l13          5.781e-02  4.204e-02   1.375 0.169532
## GDP.l13                8.913e-04  3.540e-04   2.518 0.012042 *
## const                  9.189e-02  4.575e-02   2.009 0.044958 *
## trend                  5.343e-04  2.856e-04   1.871 0.061821 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2675 on 689 degrees of freedom
## Multiple R-Squared: 0.4708,  Adjusted R-squared: 0.4301
## F-statistic: 11.56 on 53 and 689 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation Inflation:
## ==========================================
## Inflation = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_
data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemployment_
Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + GDP
.l5 + Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 +
Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8 + Inflation.l8 + GDP.l8 + Unemployment_Rate.l9 +
consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 +
Unemployment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 +
Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l13 + Inflation.l13 + GDP.l13 + const + trend
##
##                         Estimate Std. Error t value Pr(>|t|)
## Unemployment_Rate.l1  -1.118e-01  5.622e-02  -1.988  0.04718 *
## consumer_data.l1       7.876e-02  3.503e-02   2.248  0.02487 *
## Inflation.l1           1.327e+00  3.873e-02  34.267  < 2e-16 ***
## GDP.l1                 9.356e-04  3.039e-04   3.079  0.00216 **
## Unemployment_Rate.l2   8.795e-02  7.627e-02   1.153  0.24921
## consumer_data.l2       8.439e-02  3.598e-02   2.345  0.01930 *
## Inflation.l2          -6.061e-01  6.362e-02  -9.527  < 2e-16 ***
## GDP.l2                -2.397e-04  4.075e-04  -0.588  0.55653
## Unemployment_Rate.l3   1.001e-01  7.652e-02   1.308  0.19117
## consumer_data.l3      -7.264e-03  3.567e-02  -0.204  0.83867
## Inflation.l3           3.598e-01  6.731e-02   5.346 1.23e-07 ***
## GDP.l3                -9.449e-04  4.093e-04  -2.308  0.02128 *
## Unemployment_Rate.l4  -5.348e-02  7.648e-02  -0.699  0.48465
## consumer_data.l4      -2.646e-02  3.572e-02  -0.741  0.45909
## Inflation.l4          -1.746e-01  6.843e-02  -2.551  0.01095 *
## GDP.l4                -1.158e-04  4.351e-04  -0.266  0.79015
## Unemployment_Rate.l5  -9.400e-02  7.659e-02  -1.227  0.22009
## consumer_data.l5      -4.913e-02  3.571e-02  -1.376  0.16929
## Inflation.l5           1.468e-01  6.823e-02   2.151  0.03185 *
## GDP.l5                 4.396e-05  4.545e-04   0.097  0.92299
## Unemployment_Rate.l6   9.596e-02  7.674e-02   1.250  0.21156
## consumer_data.l6       4.674e-02  3.565e-02   1.311  0.19018
## Inflation.l6          -1.330e-01  6.811e-02  -1.953  0.05122 .
## GDP.l6                 4.182e-04  4.543e-04   0.920  0.35764
## Unemployment_Rate.l7  -9.611e-03  7.663e-02  -0.125  0.90023
## consumer_data.l7      -4.462e-03  3.565e-02  -0.125  0.90042
## Inflation.l7           9.506e-03  6.833e-02   0.139  0.88939
## GDP.l7                -2.449e-05  4.565e-04  -0.054  0.95723
## Unemployment_Rate.l8  -3.271e-02  7.666e-02  -0.427  0.66974
```

```
## consumer_data.l8       1.989e-02  3.564e-02   0.558  0.57686
## Inflation.l8           1.299e-01  6.809e-02   1.908  0.05685 .
## GDP.l8                -7.862e-04  4.552e-04  -1.727  0.08459 .
## Unemployment_Rate.l9  -9.975e-02  7.652e-02  -1.304  0.19283
## consumer_data.l9       4.676e-02  3.564e-02   1.312  0.18992
## Inflation.l9          -1.171e-01  6.786e-02  -1.726  0.08479 .
## GDP.l9                 1.069e-03  4.624e-04   2.311  0.02110 *
## Unemployment_Rate.l10  6.952e-02  7.649e-02   0.909  0.36369
## consumer_data.l10      6.419e-04  3.540e-02   0.018  0.98554
## Inflation.l10          4.363e-02  6.790e-02   0.643  0.52072
## GDP.l10               -1.120e-03  4.458e-04  -2.511  0.01225 *
## Unemployment_Rate.l11  1.117e-01  7.612e-02   1.468  0.14255
## consumer_data.l11      4.051e-02  3.520e-02   1.151  0.25021
## Inflation.l11          6.110e-02  6.669e-02   0.916  0.35986
## GDP.l11                9.512e-04  4.253e-04   2.237  0.02564 *
## Unemployment_Rate.l12 -6.196e-02  7.591e-02  -0.816  0.41464
## consumer_data.l12      1.405e-02  3.551e-02   0.396  0.69249
## Inflation.l12         -1.521e-01  6.257e-02  -2.431  0.01532 *
## GDP.l12               -4.056e-04  4.295e-04  -0.944  0.34532
## Unemployment_Rate.l13 -6.838e-04  5.384e-02  -0.013  0.98987
## consumer_data.l13     -9.678e-03  3.506e-02  -0.276  0.78261
## Inflation.l13          8.140e-02  3.820e-02   2.131  0.03346 *
## GDP.l13                2.045e-04  3.217e-04   0.636  0.52516
## const                  4.837e-02  4.157e-02   1.164  0.24501
## trend                  2.829e-04  2.595e-04   1.090  0.27615
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.243 on 689 degrees of freedom
## Multiple R-Squared: 0.9931,  Adjusted R-squared: 0.9926
## F-statistic:  1881 on 53 and 689 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation GDP:
## ====================================
## GDP = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_data.l
2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemployment_Rate.l
4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + GDP.l5 +
Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 + Infla
tion.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8 + Inflation.l8 + GDP.l8 + Unemployment_Rate.l9 + consu
mer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 + Unemp
loyment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 + Infl
ation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l13 + Inflation.l13 + GDP.l13 + const + trend
##
##                         Estimate Std. Error t value Pr(>|t|)
## Unemployment_Rate.l1    4.081450   7.220963   0.565 0.572107
## consumer_data.l1        7.512270   4.499413   1.670 0.095451 .
## Inflation.l1            0.432604   4.974450   0.087 0.930724
## GDP.l1                  0.914162   0.039030  23.422  < 2e-16 ***
## Unemployment_Rate.l2   -9.312004   9.795435  -0.951 0.342117
## consumer_data.l2       10.497993   4.621580   2.272 0.023423 *
## Inflation.l2           -4.587956   8.171345  -0.561 0.574660
## GDP.l2                  0.014571   0.052333   0.278 0.780771
## Unemployment_Rate.l3   -1.273577   9.828472  -0.130 0.896936
## consumer_data.l3        3.777734   4.580802   0.825 0.409834
## Inflation.l3            2.705862   8.645501   0.313 0.754391
## GDP.l3                  0.483973   0.052575   9.205  < 2e-16 ***
## Unemployment_Rate.l4   -0.413879   9.823489  -0.042 0.966406
## consumer_data.l4        2.531038   4.587594   0.552 0.581323
## Inflation.l4            1.075011   8.789093   0.122 0.902688
## GDP.l4                 -0.441842   0.055886  -7.906 1.06e-14 ***
## Unemployment_Rate.l5    9.433491   9.836768   0.959 0.337894
## consumer_data.l5       -5.858395   4.586440  -1.277 0.201916
## Inflation.l5           -1.408171   8.763936  -0.161 0.872394
## GDP.l5                  0.018635   0.058380   0.319 0.749671
## Unemployment_Rate.l6    8.588604   9.856243   0.871 0.383846
## consumer_data.l6        2.951433   4.578310   0.645 0.519365
## Inflation.l6           -1.415913   8.748364  -0.162 0.871472
## GDP.l6                  0.183923   0.058351   3.152 0.001692 **
## Unemployment_Rate.l7   -4.798232   9.842553  -0.487 0.626060
## consumer_data.l7        1.198979   4.578585   0.262 0.793503
## Inflation.l7            0.771676   8.775794   0.088 0.929956
## GDP.l7                 -0.172555   0.058627  -2.943 0.003357 **
## Unemployment_Rate.l8    2.049531   9.846560   0.208 0.835176
## consumer_data.l8       -8.308742   4.576945  -1.815 0.069905 .
## Inflation.l8            4.759044   8.745247   0.544 0.586489
## GDP.l8                 -0.002011   0.058466  -0.034 0.972576
## Unemployment_Rate.l9    1.363641   9.828668   0.139 0.889695
```

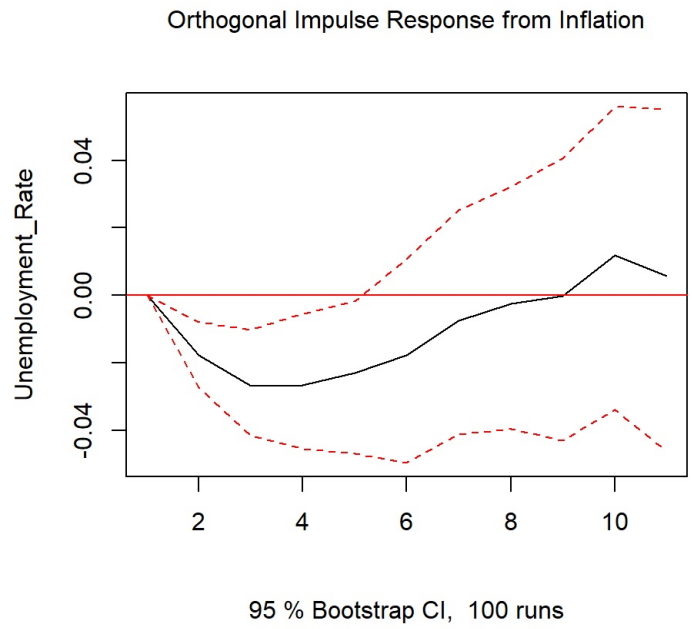
```
## consumer_data.l9       -7.697114   4.577662  -1.681 0.093129 .
## Inflation.l9            2.470140   8.716171   0.283 0.776957
## GDP.l9                  0.207055   0.059391   3.486 0.000521 ***
## Unemployment_Rate.l10  -7.831061   9.823689  -0.797 0.425632
## consumer_data.l10       4.190074   4.546821   0.922 0.357091
## Inflation.l10          -4.551402   8.720668  -0.522 0.601901
## GDP.l10                -0.219403   0.057260  -3.832 0.000139 ***
## Unemployment_Rate.l11   1.730858   9.776812   0.177 0.859531
## consumer_data.l11      -2.769663   4.520985  -0.613 0.540327
## Inflation.l11          11.215757   8.565357   1.309 0.190824
## GDP.l11                -0.032416   0.054627  -0.593 0.553106
## Unemployment_Rate.l12  -2.235174   9.749780  -0.229 0.818740
## consumer_data.l12     -12.677999   4.561462  -2.779 0.005595 **
## Inflation.l12          -7.311485   8.036773  -0.910 0.363270
## GDP.l12                 0.069793   0.055168   1.265 0.206262
## Unemployment_Rate.l13   0.148395   6.914784   0.021 0.982885
## consumer_data.l13      -4.707143   4.503282  -1.045 0.296265
## Inflation.l13          -5.083791   4.906710  -1.036 0.300524
## GDP.l13                -0.025543   0.041320  -0.618 0.536662
## const                  -7.142753   5.339413  -1.338 0.181422
## trend                   0.074782   0.033334   2.243 0.025189 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 31.22 on 689 degrees of freedom
## Multiple R-Squared:     1,   Adjusted R-squared:     1
## F-statistic: 4.966e+05 on 53 and 689 DF,  p-value: < 2.2e-16
##
##
##
## Covariance matrix of residuals:
##                   Unemployment_Rate consumer_data Inflation      GDP
## Unemployment_Rate         0.0279462    -0.0009999 -0.006893  -0.8083
## consumer_data            -0.0009999     0.0715352  0.006841   1.3955
## Inflation                -0.0068934     0.0068412  0.059071   0.4838
## GDP                      -0.8082577     1.3954884  0.483779 974.4636
##
## Correlation matrix of residuals:
##                   Unemployment_Rate consumer_data Inflation      GDP
## Unemployment_Rate           1.00000      -0.02236  -0.16966 -0.15488
## consumer_data              -0.02236       1.00000   0.10524  0.16714
## Inflation                  -0.16966       0.10524   1.00000  0.06376
## GDP                        -0.15488       0.16714   0.06376  1.00000
```

```
# plot(var_model)
# plot(var_lag_selection, xlabel = "Unemployment_Rate", ylabel = "Inflation", zlab)

# Causality Test
granger_causality_test <- causality(var_model, cause = "Inflation")
print(granger_causality_test)
```

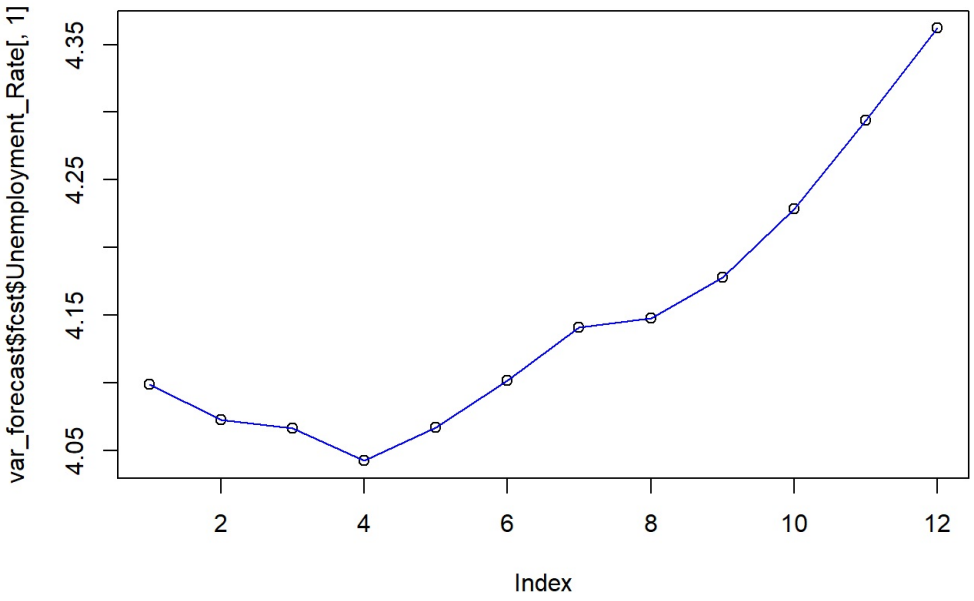
```
## $Granger
##
##  Granger causality H0: Inflation do not Granger-cause Unemployment_Rate
##  consumer_data GDP
##
## data:  VAR object var_model
## F-Test = 1.3956, df1 = 39, df2 = 2756, p-value = 0.05302
##
##
## $Instant
##
##  H0: No instantaneous causality between: Inflation and Unemployment_Rate
##  consumer_data GDP
##
## data:  VAR object var_model
## Chi-squared = 28.261, df = 3, p-value = 3.202e-06
```

```
# Analyzing Impulse Response Function
IRF <- irf(var_model, impulse = "Inflation", response = "Unemployment_Rate")
plot(IRF)
```

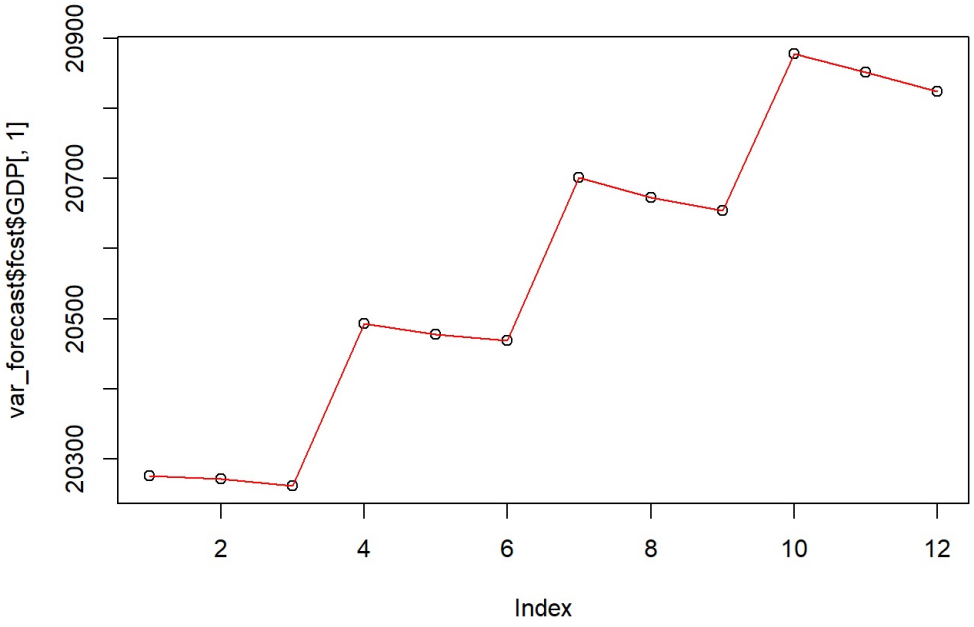



```
# Forecast for 12 months
var_forecast <- predict(var_model, n.ahead = 12)

plot(var_forecast$fcst$Unemployment_Rate[,1])
lines(var_forecast$fcst$Unemployment_Rate[,1], col = "blue")
```




```
plot(var_forecast$fcst$GDP[,1])
lines(var_forecast$fcst$GDP[,1], col = "red")
```


var_forecast$fcst$GDP[, 1]
20300
20500
20700
20900
2
4
6
8
10
12
Index