```
R version 4.3.1 (2023-06-16 ucrt) -- "Beagle Scouts"
Copyright (C) 2023 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> install.packages("readxl")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
(as ‘lib’ is unspecified)
--- Please select a CRAN mirror for use in this session ---
trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/readxl_1.4.3.zip'
Content type 'application/zip' length 1197261 bytes (1.1 MB)
downloaded 1.1 MB

package ‘readxl’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> install.packages("seasonal")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
(as ‘lib’ is unspecified)
trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/seasonal_1.9.0.zip'
Content type 'application/zip' length 549590 bytes (536 KB)
downloaded 536 KB

package ‘seasonal’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> library(readxl)
Warning message:
package ‘readxl’ was built under R version 4.3.3
> library(seasonal)
Warning message:
package ‘seasonal’ was built under R version 4.3.3
> data <- read.csv("C:Users/minhas01/Desktop/Nahayan Minhas/US Net Capital Mthly Inflows Level Ch
anged Qrtly.csv")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") :
  cannot open file 'C:Users/minhas01/Desktop/Nahayan Minhas/US Net Capital Mthly Inflows Level Ch
anged Qrtly.csv': No such file or directory
> data <- read.csv("C:Users/minhas01/Desktop/Nahayan Minhas/US Net Capital Mthly Inflows Level Ch
anged Qrtly.csv")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") :
  cannot open file 'C:Users/minhas01/Desktop/Nahayan Minhas/US Net Capital Mthly Inflows Level Ch
anged Qrtly.csv': No such file or directory
> data <- read.csv("C:Users/minhas01/Desktop/Nahayan Minhas/Data for R Analysis/US Net Capital Mt
hly Inflows Level Changed Qrtly.csv")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") :
  cannot open file 'C:Users/minhas01/Desktop/Nahayan Minhas/Data for R Analysis/US Net Capital Mt
hly Inflows Level Changed Qrtly.csv': No such file or directory
> data <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/Data for R Analysis/US Net Capital M
```

```
thly Inflows Level Changed Qrtly.csv")
Error: bidi formatting not allowed, use escapes instead (\u202a) (<input>:1:19)
> data <- read.csv("C:/Users/minhas01/Desktop/USDebt.csv")
> data$Date <- sub("^00(\\d{2})", "19\\1", data$Date)
> head(data$Date)
[1] "3/31/1994"  "6/30/1994"  "9/30/1994"  "12/31/1994" "3/31/1995"  "6/30/1995"
> data$Date <- as.Date(data$Date, format="%m/%d/%Y")
> head(data$Date)
[1] "1994-03-31" "1994-06-30" "1994-09-30" "1994-12-31" "1995-03-31" "1995-06-30"
> if (!any(is.na(data$Date))) {
+   data$Year <- as.numeric(format(data$Date, "%Y"))
+   data$Quarter <- ceiling(as.numeric(format(data$Date, "%m")) / 3)
+ head(data$Year)
+   head(data$Quarter)
+ } else {
+   print("There was an error converting the dates.")
+ }
[1] 1 2 3 4 1 2
> ts_data <- ts(data$Value, frequency=4, start=c(min(data$Year), min(data$Quarter)))
Error in ts(data$Value, frequency = 4, start = c(min(data$Year), min(data$Quarter))) :
  'ts' object must have one or more observations
>  data <- read.csv("C:/Users/minhas01/Desktop/USDebt.csv")
>  data$Date <- sub("^00(\\d{2})", "19\\1", data$Date)
>  head(data$Date)
[1] "3/31/1994"  "6/30/1994"  "9/30/1994"  "12/31/1994" "3/31/1995"  "6/30/1995"
> data$Date <- as.Date(data$Date, format="%m/%d/%Y")
>  head(data$Date)
[1] "1994-03-31" "1994-06-30" "1994-09-30" "1994-12-31" "1995-03-31" "1995-06-30"
>  if (!any(is.na(data$Date))) {
+ +   data$Year <- as.numeric(format(data$Date, "%Y"))
+ +   data$Quarter <- ceiling(as.numeric(format(data$Date, "%m")) / 3)
+ + head(data$Year)
+ +   head(data$Quarter)
+ + } else {
Error: unexpected '}' in:
"+   head(data$Quarter)
+ }"
> +   print("There was an error converting the dates.")
[1] "There was an error converting the dates."
Error in +print("There was an error converting the dates.") :
  invalid argument to unary operator
> + }
Error: unexpected '}' in "+ }"
> if (!any(is.na(data$Date))) {
+   data$Year <- as.numeric(format(data$Date, "%Y"))
+   data$Quarter <- ceiling(as.numeric(format(data$Date, "%m")) / 3)
+ head(data$Year)
+   head(data$Quarter)
+ } else {
+   print("There was an error converting the dates.")
+ }
[1] 1 2 3 4 1 2
> ts_data <- ts(data$Value, frequency=4, start=c(min(data$Year), min(data$Quarter)))
> sa_results <- seas(ts_data)
Model used in SEATS is different: (0 0 0)
> adjusted <- final(sa_results)
> plot(ts_data, main = "Original vs. Seasonally Adjusted", col = "blue", ylab="Value", xlab="Time
")
> lines(adjusted, col = "red")
> legend("topright", legend = c("Original", "Adjusted"), col = c("blue", "red"), lty = 1, bty = "
n")
Error in (function (s, units = "user", cex = NULL, font = NULL, vfont = NULL,  :
  plot.new has not been called yet

> > data <- read.csv("C:/Users/minhas01/Desktop/USDXY.csv")
> data$Date <- sub("^00(\\d{2})", "19\\1", data$Date)
>  head(data$Date)
[1] "3/31/1994"  "6/30/1994"  "9/30/1994"  "12/30/1994" "3/31/1995"  "9/29/1995"
>  data$Date <- as.Date(data$Date, format="%m/%d/%Y")
>
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> data$Date <- as.Date(data$Date, format="%m/%d/%Y")
> head(data$Date)
[1] "1994-03-31" "1994-06-30" "1994-09-30" "1994-12-30" "1995-03-31" "1995-09-29"
> if (!any(is.na(data$Date))) {
+   data$Year <- as.numeric(format(data$Date, "%Y"))
+   data$Quarter <- ceiling(as.numeric(format(data$Date, "%m")) / 3)
+ head(data$Year)
+   head(data$Quarter)
+ } else {
+   print("There was an error converting the dates.")
+ }
[1] 1 2 3 4 1 3
> ts_data <- ts(data$Value, frequency=4, start=c(min(data$Year), min(data$Quarter)))
> sa_results <- seas(ts_data)
Model used in SEATS is different: (0 0 0)
> summary(sa_results)

Call:
seas(x = ts_data)

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
MA-Nonseasonal-01 -0.34150    0.08656  -3.945 7.97e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

SEATS adj.  ARIMA: (0 0 1)  Obs.: 119  Transform: none
AICc: 681.8, BIC: 687.3  QS (no seasonality in final):    0
Box-Ljung (no autocorr.): 17.08   Shapiro (normality): 0.9864
Messages generated by X-13:
Warnings:
- Automatic transformation selection cannot be done on a series with zero or negative values.

Notes:
- Model used for SEATS decomposition is different from the model estimated in the regARIMA modeli
ng module of X-13ARIMA-SEATS.

> install.packages("vars")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
(as ‘lib’ is unspecified)
also installing the dependencies ‘zoo’, ‘strucchange’, ‘urca’, ‘lmtest’, ‘sandwich’

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/zoo_1.8-12.zip'
Content type 'application/zip' length 1020531 bytes (996 KB)
downloaded 996 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/strucchange_1.5-3.zip'
Content type 'application/zip' length 947106 bytes (924 KB)
downloaded 924 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/urca_1.3-3.zip'
Content type 'application/zip' length 1109075 bytes (1.1 MB)
downloaded 1.1 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/lmtest_0.9-40.zip'
Content type 'application/zip' length 405925 bytes (396 KB)
downloaded 396 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/sandwich_3.1-0.zip'
Content type 'application/zip' length 1508756 bytes (1.4 MB)
downloaded 1.4 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/vars_1.6-1.zip'
Content type 'application/zip' length 425536 bytes (415 KB)
downloaded 415 KB

package ‘zoo’ successfully unpacked and MD5 sums checked
package ‘strucchange’ successfully unpacked and MD5 sums checked
package ‘urca’ successfully unpacked and MD5 sums checked
package ‘lmtest’ successfully unpacked and MD5 sums checked
```

```
package ‘sandwich’ successfully unpacked and MD5 sums checked
package ‘vars’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> install.packages("readr")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
(as ‘lib’ is unspecified)
also installing the dependencies ‘bit’, ‘bit64’, ‘tidyselect’, ‘withr’, ‘clipr’, ‘vroom’, ‘tzdb’

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/bit_4.0.5.zip'
Content type 'application/zip' length 1136720 bytes (1.1 MB)
downloaded 1.1 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/bit64_4.0.5.zip'
Content type 'application/zip' length 494921 bytes (483 KB)
downloaded 483 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/tidyselect_1.2.1.zip'
Content type 'application/zip' length 225188 bytes (219 KB)
downloaded 219 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/withr_3.0.0.zip'
Content type 'application/zip' length 246001 bytes (240 KB)
downloaded 240 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/clipr_0.8.0.zip'
Content type 'application/zip' length 54687 bytes (53 KB)
downloaded 53 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/vroom_1.6.5.zip'
Content type 'application/zip' length 1331241 bytes (1.3 MB)
downloaded 1.3 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/tzdb_0.4.0.zip'
Content type 'application/zip' length 1032572 bytes (1008 KB)
downloaded 1008 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/readr_2.1.5.zip'
Content type 'application/zip' length 1172532 bytes (1.1 MB)
downloaded 1.1 MB

package ‘bit’ successfully unpacked and MD5 sums checked
package ‘bit64’ successfully unpacked and MD5 sums checked
package ‘tidyselect’ successfully unpacked and MD5 sums checked
package ‘withr’ successfully unpacked and MD5 sums checked
package ‘clipr’ successfully unpacked and MD5 sums checked
package ‘vroom’ successfully unpacked and MD5 sums checked
package ‘tzdb’ successfully unpacked and MD5 sums checked
package ‘readr’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> library(vars)
Loading required package: MASS
Loading required package: strucchange
Loading required package: zoo

Attaching package: ‘zoo’

The following objects are masked from ‘package:base’:

    as.Date, as.Date.numeric

Loading required package: sandwich
Loading required package: urca
Loading required package: lmtest
Warning messages:
1: package ‘vars’ was built under R version 4.3.3
2: package ‘strucchange’ was built under R version 4.3.3
```

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3: package ‘zoo’ was built under R version 4.3.3
4: package ‘sandwich’ was built under R version 4.3.3
5: package ‘urca’ was built under R version 4.3.3
6: package ‘lmtest’ was built under R version 4.3.3
> library(readr)
Warning message:
package ‘readr’ was built under R version 4.3.3
> var1 <- read_csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
[1mindexing[0m [34m3M TBill SA.csv[0m [=================================================
================================================================================================
==========================] [32m45.66MB/s[0m, eta: [36m 0s[0m


                                  Rows: 120 Columns: 2
── Column specification ────────────────────────────────────────────────────────────────────────
────────────────────────────────────────────────────────────────────────────────────────────────
Delimiter: ","
chr (1): Date
dbl (1): Value

ℹ Use `spec()` to retrieve the full column specification for this data.
ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
> var1 <- read_csv("path_to_your_file.csv",
+                  col_types = cols(
+                    Date = col_date(format = "%m/%d/%Y"),
+                    Value = col_double()
+
+
+
+
+
+
+

+ > AAAAA
Error: object 'AAAAA' not found
> library(vars)
>
> library(readr)
>
> data1 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data2 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US CPI SA.csv")
> data3 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US IP SA.csv")
> data4 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US Unemployment SA.csv")
> data5 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDebt SA.csv")
> data6 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDXY SA.csv")
> data1$Date <- as.Date(data1$Date, format="%m/%d/%Y")
> data2$Date <- as.Date(data2$Date, format="%m/%d/%Y")
> data3$Date <- as.Date(data3$Date, format="%m/%d/%Y")
> data4$Date <- as.Date(data4$Date, format="%m/%d/%Y")
> data5$Date <- as.Date(data5$Date, format="%m/%d/%Y")
> data6$Date <- as.Date(data6$Date, format="%m/%d/%Y")
> anyNA(data1$Date)
[1] FALSE
> anyNA(data2$Date)
[1] FALSE
> anyNA(data3$Date)
[1] FALSE
> anyNA(data4$Date)
[1] FALSE
> anyNA(data5$Date)
[1] FALSE
> anyNA(data6$Date)
[1] FALSE
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
Error in year(min(data1$Date)) : could not find function "year"
> install.packages("lubridate")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
(as ‘lib’ is unspecified)
```

```
also installing the dependencies ‘generics’, ‘timechange’

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/generics_0.1.3.zip'
Content type 'application/zip' length 80415 bytes (78 KB)
downloaded 78 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/timechange_0.3.0.zip'
Content type 'application/zip' length 507755 bytes (495 KB)
downloaded 495 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/lubridate_1.9.3.zip'
Content type 'application/zip' length 984899 bytes (961 KB)
downloaded 961 KB

package ‘generics’ successfully unpacked and MD5 sums checked
package ‘timechange’ successfully unpacked and MD5 sums checked
package ‘lubridate’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> library(lubridate)

Attaching package: ‘lubridate’

The following objects are masked from ‘package:base’:

    date, intersect, setdiff, union

Warning message:
package ‘lubridate’ was built under R version 4.3.3
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> ts2 <- ts(data2[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> ts3 <- ts(data3[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> ts4 <- ts(data4[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> ts5 <- ts(data5[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> ts6 <- ts(data6[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
> mts_data <- cbind(ts1, ts2, ts3, ts4, ts5, ts6)
> var_model <- VAR(mts_data, p=8)
Error in VAR(mts_data, p = 8) :
NAs in y.
> data1 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> > data2 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US CPI SA.csv")
Error: unexpected '>' in ">"
> > data3 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US IP SA.csv")
Error: unexpected '>' in ">"
> > data4 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US Unemployment SA.csv")
Error: unexpected '>' in ">"
> > data5 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDebt SA.csv")
Error: unexpected '>' in ">"
> > data6 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDXY SA.csv")
Error: unexpected '>' in ">"
> > data1$Date <- as.Date(data1$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> > data2$Date <- as.Date(data2$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> > data3$Date <- as.Date(data3$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> > data4$Date <- as.Date(data4$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> > data5$Date <- as.Date(data5$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> > data6$Date <- as.Date(data6$Date, format="%m/%d/%Y")
Error: unexpected '>' in ">"
> data2 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data3 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data4 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data5 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data6 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
Error in as.POSIXlt.character(x, tz = tz(x)) :
```

```
  character string is not in a standard unambiguous format
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
Error in as.POSIXlt.character(x, tz = tz(x)) :
  character string is not in a standard unambiguous format
> library(lubridate)
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
Error in as.POSIXlt.character(x, tz = tz(x)) :
  character string is not in a standard unambiguous format
> data1 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> ts1 <- ts(data1[,2], start=c(year(min(data1$Date)), month(min(data1$Date))), frequency=4)
Error in as.POSIXlt.character(x, tz = tz(x)) :
  character string is not in a standard unambiguous format
> data1$Date <- as.Date(data1$Date, format="%m/%d/%Y")
> str(data1$Date)
 Date[1:120], format: "1994-03-31" "1994-06-30" "1994-09-30" "1994-12-31" "1995-03-31" "1995-06-3
0" "1995-09-30" "1995-12-31" "1996-03-31" "1996-06-30" "1996-09-30" "1996-12-31" "1997-03-31" "19
97-06-30" "1997-09-30" "1997-12-31" ...
> start_year <- year(min(data1$Date))
> start_month <- month(min(data1$Date))
> print(start_year)
[1] 1994
> print(start_month)
[1] 3
> ts1 <- ts(data1[,2], start=c(start_year, start_month), frequency=4)
> ts2 <- ts(data1[,2], start=c(start_year, start_month), frequency=4)
> ts2 <- ts(data2[,2], start=c(start_year, start_month), frequency=4)
> ts1 <- ts(data1[,2], start=c(start_year, start_month), frequency=4)
> ts3 <- ts(data3[,2], start=c(start_year, start_month), frequency=4)
> ts4 <- ts(data4[,2], start=c(start_year, start_month), frequency=4)
> ts5 <- ts(data5[,2], start=c(start_year, start_month), frequency=4)
> ts6 <- ts(data6[,2], start=c(start_year, start_month), frequency=4)
> anyNA(data1$Date)
[1] FALSE
> anyNA(data2$Date)
[1] FALSE
> anyNA(data3$Date)
[1] FALSE
> anyNA(data4$Date)
[1] FALSE
> anyNA(data5$Date)
[1] FALSE
> anyNA(data6$Date)
[1] FALSE
> mts_data <- cbind(ts1, ts2, ts3, ts4, ts5, ts6)
> var_model <- VAR(mts_data, p=8)
> summary(var_model)
Error in solve.default(Sigma) :
  Lapack routine dgesv: system is exactly singular: U[2,2] = 0
> apply(data1[, -1], 2, var)
Error in apply(data1[, -1], 2, var) : dim(X) must have a positive length
> apply(data1[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> apply(data2[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> apply(data3[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> apply(data4[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> apply(data5[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> apply(data6[, -1, drop = FALSE], 2, var)
    Value
0.2255839
> install.packages("car")
Installing package into ‘C:/Users/minhas01/AppData/Local/R/win-library/4.3’
```

```
(as 'lib' is unspecified)
also installing the dependencies 'fs', 'pkgbuild', 'rprojroot', 'diffobj', 'rematch2', 'stringi',
 'brio', 'callr', 'desc', 'digest', 'evaluate', 'jsonlite', 'pkgload', 'praise', 'processx', 'ps'
, 'waldo', 'backports', 'ellipsis', 'purrr', 'stringr', 'tidyr', 'Matrix', 'testthat', 'colorspac
e', 'broom', 'dplyr', 'numDeriv', 'SparseM', 'MatrixModels', 'minqa', 'nloptr', 'Rcpp', 'RcppEige
n', 'farver', 'labeling', 'munsell', 'RColorBrewer', 'viridisLite', 'carData', 'abind', 'pbkrtest
', 'quantreg', 'lme4', 'scales'


  There is a binary version available but the source version is later:
         binary  source needs_compilation
testthat  3.2.1 3.2.1.1              TRUE

  Binaries will be installed
trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/fs_1.6.3.zip'
Content type 'application/zip' length 393952 bytes (384 KB)
downloaded 384 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/pkgbuild_1.4.4.zip'
Content type 'application/zip' length 202485 bytes (197 KB)
downloaded 197 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/rprojroot_2.0.4.zip'
Content type 'application/zip' length 113611 bytes (110 KB)
downloaded 110 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/diffobj_0.3.5.zip'
Content type 'application/zip' length 1006897 bytes (983 KB)
downloaded 983 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/rematch2_2.1.2.zip'
Content type 'application/zip' length 47517 bytes (46 KB)
downloaded 46 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/stringi_1.8.3.zip'
Content type 'application/zip' length 14998651 bytes (14.3 MB)
downloaded 14.3 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/brio_1.1.4.zip'
Content type 'application/zip' length 40388 bytes (39 KB)
downloaded 39 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/callr_3.7.6.zip'
Content type 'application/zip' length 460456 bytes (449 KB)
downloaded 449 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/desc_1.4.3.zip'
Content type 'application/zip' length 329808 bytes (322 KB)
downloaded 322 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/digest_0.6.35.zip'
Content type 'application/zip' length 217636 bytes (212 KB)
downloaded 212 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/evaluate_0.23.zip'
Content type 'application/zip' length 84130 bytes (82 KB)
downloaded 82 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/jsonlite_1.8.8.zip'
Content type 'application/zip' length 1105680 bytes (1.1 MB)
downloaded 1.1 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/pkgload_1.3.4.zip'
Content type 'application/zip' length 179711 bytes (175 KB)
downloaded 175 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/praise_1.0.0.zip'
Content type 'application/zip' length 19864 bytes (19 KB)
downloaded 19 KB
```

```
trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/processx_3.8.4.zip'
Content type 'application/zip' length 686717 bytes (670 KB)
downloaded 670 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/ps_1.7.6.zip'
Content type 'application/zip' length 553130 bytes (540 KB)
downloaded 540 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/waldo_0.5.2.zip'
Content type 'application/zip' length 105112 bytes (102 KB)
downloaded 102 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/backports_1.4.1.zip'
Content type 'application/zip' length 101330 bytes (98 KB)
downloaded 98 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/ellipsis_0.3.2.zip'
Content type 'application/zip' length 40504 bytes (39 KB)
downloaded 39 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/purrr_1.0.2.zip'
Content type 'application/zip' length 499240 bytes (487 KB)
downloaded 487 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/stringr_1.5.1.zip'
Content type 'application/zip' length 319042 bytes (311 KB)
downloaded 311 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/tidyr_1.3.1.zip'
Content type 'application/zip' length 1267041 bytes (1.2 MB)
downloaded 1.2 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/Matrix_1.6-5.zip'
Content type 'application/zip' length 4556853 bytes (4.3 MB)
downloaded 4.3 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/testthat_3.2.1.zip'
Content type 'application/zip' length 2222964 bytes (2.1 MB)
downloaded 2.1 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/colorspace_2.1-0.zip'
Content type 'application/zip' length 2629637 bytes (2.5 MB)
downloaded 2.5 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/broom_1.0.5.zip'
Content type 'application/zip' length 1862685 bytes (1.8 MB)
downloaded 1.8 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/dplyr_1.1.4.zip'
Content type 'application/zip' length 1560172 bytes (1.5 MB)
downloaded 1.5 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/numDeriv_2016.8-1.1.zip'
Content type 'application/zip' length 116116 bytes (113 KB)
downloaded 113 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/SparseM_1.81.zip'
Content type 'application/zip' length 1042203 bytes (1017 KB)
downloaded 1017 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/MatrixModels_0.5-3.zip'
Content type 'application/zip' length 414375 bytes (404 KB)
downloaded 404 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/minqa_1.2.6.zip'
Content type 'application/zip' length 459251 bytes (448 KB)
downloaded 448 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/nloptr_2.0.3.zip'
Content type 'application/zip' length 1011763 bytes (988 KB)
```

```
downloaded 988 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/Rcpp_1.0.12.zip'
Content type 'application/zip' length 2877947 bytes (2.7 MB)
downloaded 2.7 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/RcppEigen_0.3.4.0.0.zip'
Content type 'application/zip' length 2611015 bytes (2.5 MB)
downloaded 2.5 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/farver_2.1.1.zip'
Content type 'application/zip' length 1505868 bytes (1.4 MB)
downloaded 1.4 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/labeling_0.4.3.zip'
Content type 'application/zip' length 62568 bytes (61 KB)
downloaded 61 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/munsell_0.5.1.zip'
Content type 'application/zip' length 245466 bytes (239 KB)
downloaded 239 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/RColorBrewer_1.1-3.zip'
Content type 'application/zip' length 56066 bytes (54 KB)
downloaded 54 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/viridisLite_0.4.2.zip'
Content type 'application/zip' length 1300105 bytes (1.2 MB)
downloaded 1.2 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/carData_3.0-5.zip'
Content type 'application/zip' length 1822266 bytes (1.7 MB)
downloaded 1.7 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/abind_1.4-5.zip'
Content type 'application/zip' length 63774 bytes (62 KB)
downloaded 62 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/pbkrtest_0.5.2.zip'
Content type 'application/zip' length 191208 bytes (186 KB)
downloaded 186 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/quantreg_5.97.zip'
Content type 'application/zip' length 1562933 bytes (1.5 MB)
downloaded 1.5 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/lme4_1.1-35.2.zip'
Content type 'application/zip' length 4557183 bytes (4.3 MB)
downloaded 4.3 MB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/scales_1.3.0.zip'
Content type 'application/zip' length 703730 bytes (687 KB)
downloaded 687 KB

trying URL 'https://cran.case.edu/bin/windows/contrib/4.3/car_3.1-2.zip'
Content type 'application/zip' length 1707812 bytes (1.6 MB)
downloaded 1.6 MB

package ‘fs’ successfully unpacked and MD5 sums checked
package ‘pkgbuild’ successfully unpacked and MD5 sums checked
package ‘rprojroot’ successfully unpacked and MD5 sums checked
package ‘diffobj’ successfully unpacked and MD5 sums checked
package ‘rematch2’ successfully unpacked and MD5 sums checked
package ‘stringi’ successfully unpacked and MD5 sums checked
package ‘brio’ successfully unpacked and MD5 sums checked
package ‘callr’ successfully unpacked and MD5 sums checked
package ‘desc’ successfully unpacked and MD5 sums checked
package ‘digest’ successfully unpacked and MD5 sums checked
package ‘evaluate’ successfully unpacked and MD5 sums checked
package ‘jsonlite’ successfully unpacked and MD5 sums checked
```

```
package ‘pkgload’ successfully unpacked and MD5 sums checked
package ‘praise’ successfully unpacked and MD5 sums checked
package ‘processx’ successfully unpacked and MD5 sums checked
package ‘ps’ successfully unpacked and MD5 sums checked
package ‘waldo’ successfully unpacked and MD5 sums checked
package ‘backports’ successfully unpacked and MD5 sums checked
package ‘ellipsis’ successfully unpacked and MD5 sums checked
package ‘purrr’ successfully unpacked and MD5 sums checked
package ‘stringr’ successfully unpacked and MD5 sums checked
package ‘tidyr’ successfully unpacked and MD5 sums checked
package ‘Matrix’ successfully unpacked and MD5 sums checked
package ‘testthat’ successfully unpacked and MD5 sums checked
package ‘colorspace’ successfully unpacked and MD5 sums checked
package ‘broom’ successfully unpacked and MD5 sums checked
package ‘dplyr’ successfully unpacked and MD5 sums checked
package ‘numDeriv’ successfully unpacked and MD5 sums checked
package ‘SparseM’ successfully unpacked and MD5 sums checked
package ‘MatrixModels’ successfully unpacked and MD5 sums checked
package ‘minqa’ successfully unpacked and MD5 sums checked
package ‘nloptr’ successfully unpacked and MD5 sums checked
package ‘Rcpp’ successfully unpacked and MD5 sums checked
package ‘RcppEigen’ successfully unpacked and MD5 sums checked
package ‘farver’ successfully unpacked and MD5 sums checked
package ‘labeling’ successfully unpacked and MD5 sums checked
package ‘munsell’ successfully unpacked and MD5 sums checked
package ‘RColorBrewer’ successfully unpacked and MD5 sums checked
package ‘viridisLite’ successfully unpacked and MD5 sums checked
package ‘carData’ successfully unpacked and MD5 sums checked
package ‘abind’ successfully unpacked and MD5 sums checked
package ‘pbkrtest’ successfully unpacked and MD5 sums checked
package ‘quantreg’ successfully unpacked and MD5 sums checked
package ‘lme4’ successfully unpacked and MD5 sums checked
package ‘scales’ successfully unpacked and MD5 sums checked
package ‘car’ successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\minhas01\AppData\Local\Temp\RtmpGAggMH\downloaded_packages
> library(car)
Loading required package: carData
Warning messages:
1: package ‘car’ was built under R version 4.3.3
2: package ‘carData’ was built under R version 4.3.3
> data2 <- read.csv("C:.csv")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") : cannot open file 'C:.csv': No such file or directory
> data1 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/3M TBill SA.csv")
> data2 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US CPI SA.csv")
> data3 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US IP SA.csv")
> data4 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/US Unemployment SA.csv")
> data5 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDebt SA.csv")
> data6 <- read.csv("C:/Users/minhas01/Desktop/Nahayan Minhas/CSV Data/USDXY SA.csv")
> data1$Date <- as.Date(data1$Date, format="%m/%d/%Y")
> data2$Date <- as.Date(data2$Date, format="%m/%d/%Y")
> data3$Date <- as.Date(data3$Date, format="%m/%d/%Y")
> data4$Date <- as.Date(data4$Date, format="%m/%d/%Y")
> data5$Date <- as.Date(data5$Date, format="%m/%d/%Y")
> data6$Date <- as.Date(data6$Date, format="%m/%d/%Y")
> ts1 <- ts(data1[,2], start=c(start_year, start_month), frequency=4)
> ts2 <- ts(data2[,2], start=c(start_year, start_month), frequency=4)
> ts3 <- ts(data3[,2], start=c(start_year, start_month), frequency=4)
> ts4 <- ts(data4[,2], start=c(start_year, start_month), frequency=4)
> ts5 <- ts(data5[,2], start=c(start_year, start_month), frequency=4)
> ts6 <- ts(data6[,2], start=c(start_year, start_month), frequency=4)
> mts_data <- cbind(ts1, ts2, ts3, ts4, ts5, ts6)
> var_model <- VAR(mts_data, p=8)
> summary(var_model)

VAR Estimation Results:
=========================
```

```
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 112
Log Likelihood: -1247.121
Roots of the characteristic polynomial:
0.9322 0.9322 0.9244 0.9244 0.9186 0.9186 0.9141 0.9125 0.9125 0.9087 0.9087 0.8834 0.8834 0.8809
 0.8809 0.8802 0.8802 0.8776 0.8776 0.8762 0.8762 0.871 0.871 0.8668 0.8668 0.8598 0.8598 0.8584
0.8584 0.8548 0.8548 0.8527 0.8527 0.8301 0.8301 0.8201 0.8201 0.8155 0.8155 0.7974 0.7974 0.7737
 0.7737 0.6445 0.6445 0.6214 0.6214 0.2645
Call:
VAR(y = mts_data, p = 8)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.4071621  0.1451618   2.805  0.00669 **
ts2.l1  0.0160823  0.0396411   0.406  0.68634
ts3.l1  0.1195472  0.0477696   2.503  0.01494 *
ts4.l1  0.0432812  0.0983072   0.440  0.66125
ts5.l1  0.0007044  0.0006794   1.037  0.30375
ts6.l1  0.0057486  0.0118797   0.484  0.63014
ts1.l2 -0.1947620  0.1685946  -1.155  0.25237
ts2.l2  0.0161757  0.0411035   0.394  0.69525
ts3.l2 -0.0204315  0.0523692  -0.390  0.69775
ts4.l2 -0.1183711  0.1024953  -1.155  0.25250
ts5.l2  0.0006939  0.0009093   0.763  0.44826
ts6.l2  0.0073743  0.0123723   0.596  0.55329
ts1.l3  0.0849648  0.1746813   0.486  0.62837
ts2.l3 -0.0032184  0.0469967  -0.068  0.94562
ts3.l3 -0.0430236  0.0585651  -0.735  0.46529
ts4.l3 -0.1986572  0.1109458  -1.791  0.07817 .
ts5.l3  0.0010374  0.0010648   0.974  0.33365
ts6.l3 -0.0144268  0.0124745  -1.157  0.25184
ts1.l4  0.1131031  0.1790124   0.632  0.52979
ts2.l4 -0.0006448  0.0506800  -0.013  0.98989
ts3.l4 -0.0916920  0.0542368  -1.691  0.09586 .
ts4.l4 -0.2188471  0.1040333  -2.104  0.03941 *
ts5.l4  0.0014324  0.0011043   1.297  0.19930
ts6.l4  0.0011384  0.0131941   0.086  0.93152
ts1.l5 -0.1747809  0.1942699  -0.900  0.37172
ts2.l5  0.0278041  0.0442002   0.629  0.53159
ts3.l5  0.0416449  0.0549159   0.758  0.45107
ts4.l5 -0.1203155  0.1035908  -1.161  0.24984
ts5.l5  0.0017232  0.0011043   1.560  0.12367
ts6.l5 -0.0057851  0.0135024  -0.428  0.66979
ts1.l6 -0.0141550  0.1968825  -0.072  0.94291
ts2.l6 -0.0466317  0.0435009  -1.072  0.28782
ts3.l6 -0.0707582  0.0557233  -1.270  0.20882
ts4.l6 -0.1279168  0.1057858  -1.209  0.23110
ts5.l6  0.0013684  0.0010859   1.260  0.21228
ts6.l6  0.0009172  0.0132262   0.069  0.94494
ts1.l7  0.0065570  0.1919249   0.034  0.97285
ts2.l7  0.0066008  0.0417085   0.158  0.87476
ts3.l7 -0.0252425  0.0537202  -0.470  0.64006
ts4.l7 -0.1068979  0.1097950  -0.974  0.33397
ts5.l7 -0.0001113  0.0010061  -0.111  0.91225
ts6.l7 -0.0241840  0.0122268  -1.978  0.05231 .
ts1.l8 -0.1285223  0.1697864  -0.757  0.45189
ts2.l8  0.0218230  0.0409548   0.533  0.59601
ts3.l8 -0.0206138  0.0515219  -0.400  0.69044
ts4.l8 -0.0259381  0.1000662  -0.259  0.79632
ts5.l8  0.0002990  0.0008101   0.369  0.71333
ts6.l8  0.0026337  0.0116856   0.225  0.82241
```

```
const  -0.0458964  0.0860694  -0.533  0.59574
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3882 on 63 degrees of freedom
Multiple R-Squared: 0.6109,     Adjusted R-squared: 0.3144
F-statistic:  2.06 on 48 and 63 DF,  p-value: 0.003652


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.4865300  0.4837906   1.006  0.31843
ts2.l1  0.1234462  0.1321146   0.934  0.35367
ts3.l1  0.2699293  0.1592050   1.695  0.09492 .
ts4.l1  0.0280901  0.3276353   0.086  0.93195
ts5.l1 -0.0027140  0.0022642  -1.199  0.23516
ts6.l1 -0.0787097  0.0395924  -1.988  0.05116 .
ts1.l2 -1.4108009  0.5618866  -2.511  0.01462 *
ts2.l2  0.2894691  0.1369884   2.113  0.03856 *
ts3.l2 -0.1208490  0.1745345  -0.692  0.49123
ts4.l2 -0.3626595  0.3415932  -1.062  0.29244
ts5.l2 -0.0046366  0.0030306  -1.530  0.13104
ts6.l2  0.0799286  0.0412340   1.938  0.05706 .
ts1.l3  0.3459173  0.5821722   0.594  0.55452
ts2.l3  0.2939428  0.1566291   1.877  0.06519 .
ts3.l3  0.0396321  0.1951839   0.203  0.83975
ts4.l3  0.0894819  0.3697567   0.242  0.80956
ts5.l3 -0.0002310  0.0035486  -0.065  0.94831
ts6.l3 -0.0155464  0.0415745  -0.374  0.70970
ts1.l4  1.9633173  0.5966070   3.291  0.00164 **
ts2.l4 -0.1915373  0.1689046  -1.134  0.26109
ts3.l4 -0.3217123  0.1807587  -1.780  0.07993 .
ts4.l4 -0.2089925  0.3467190  -0.603  0.54882
ts5.l4  0.0002785  0.0036803   0.076  0.93992
ts6.l4 -0.0003043  0.0439728  -0.007  0.99450
ts1.l5 -0.6630368  0.6474565  -1.024  0.30972
ts2.l5  0.0998861  0.1473090   0.678  0.50021
ts3.l5 -0.0694694  0.1830218  -0.380  0.70554
ts4.l5 -0.0101821  0.3452442  -0.029  0.97657
ts5.l5  0.0021201  0.0036805   0.576  0.56665
ts6.l5  0.0240804  0.0450003   0.535  0.59445
ts1.l6 -0.3933298  0.6561637  -0.599  0.55103
ts2.l6  0.1674896  0.1449786   1.155  0.25234
ts3.l6  0.0545068  0.1857127   0.294  0.77010
ts4.l6  0.6846945  0.3525595   1.942  0.05660 .
ts5.l6  0.0025139  0.0036191   0.695  0.48986
ts6.l6 -0.0232343  0.0440799  -0.527  0.59998
ts1.l7 -0.0266272  0.6396413  -0.042  0.96693
ts2.l7 -0.0225375  0.1390048  -0.162  0.87172
ts3.l7  0.0153348  0.1790370   0.086  0.93201
ts4.l7  0.3914556  0.3659214   1.070  0.28880
ts5.l7 -0.0007959  0.0033532  -0.237  0.81315
ts6.l7  0.0086331  0.0407490   0.212  0.83290
ts1.l8  0.6623238  0.5658587   1.170  0.24622
ts2.l8 -0.1013002  0.1364930  -0.742  0.46075
ts3.l8  0.0234016  0.1717105   0.136  0.89203
ts4.l8  0.7121714  0.3334976   2.135  0.03662 *
ts5.l8 -0.0004209  0.0027000  -0.156  0.87663
ts6.l8 -0.0005662  0.0389453  -0.015  0.98845
const   0.5705940  0.2868495   1.989  0.05103 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 1.294 on 63 degrees of freedom
Multiple R-Squared: 0.6563,     Adjusted R-squared: 0.3944
F-statistic: 2.506 on 48 and 63 DF,  p-value: 0.0003387


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.7472428  0.4412190   1.694  0.09528 .
ts2.l1  0.2792941  0.1204890   2.318  0.02371 *
ts3.l1  0.4702884  0.1451956   3.239  0.00192 **
ts4.l1  0.8176421  0.2988047   2.736  0.00806 **
ts5.l1 -0.0057669  0.0020650  -2.793  0.00691 **
ts6.l1 -0.0126742  0.0361084  -0.351  0.72676
ts1.l2 -0.0164987  0.5124428  -0.032  0.97442
ts2.l2 -0.2214761  0.1249340  -1.773  0.08111 .
ts3.l2  0.2572225  0.1591762   1.616  0.11110
ts4.l2  0.5165079  0.3115343   1.658  0.10230
ts5.l2 -0.0041990  0.0027639  -1.519  0.13371
ts6.l2  0.0697133  0.0376056   1.854  0.06845 .
ts1.l3  1.5272667  0.5309434   2.877  0.00548 **
ts2.l3 -0.4227306  0.1428464  -2.959  0.00434 **
ts3.l3 -0.0860550  0.1780085  -0.483  0.63047
ts4.l3 -0.2863717  0.3372196  -0.849  0.39898
ts5.l3 -0.0024300  0.0032364  -0.751  0.45554
ts6.l3 -0.0951239  0.0379162  -2.509  0.01470 *
ts1.l4 -0.9112222  0.5441080  -1.675  0.09895 .
ts2.l4  0.1171806  0.1540417   0.761  0.44967
ts3.l4 -0.0290964  0.1648527  -0.176  0.86047
ts4.l4 -0.0106475  0.3162091  -0.034  0.97324
ts5.l4 -0.0024404  0.0033564  -0.727  0.46986
ts6.l4  0.0662106  0.0401034   1.651  0.10372
ts1.l5 -1.1586452  0.5904829  -1.962  0.05416 .
ts2.l5  0.1581621  0.1343464   1.177  0.24352
ts3.l5  0.1179862  0.1669167   0.707  0.48226
ts4.l5 -0.1008534  0.3148641  -0.320  0.74980
ts5.l5  0.0015400  0.0033567   0.459  0.64796
ts6.l5 -0.0192163  0.0410405  -0.468  0.64124
ts1.l6  1.1171412  0.5984239   1.867  0.06658 .
ts2.l6 -0.1439382  0.1322210  -1.089  0.28047
ts3.l6 -0.1336546  0.1693707  -0.789  0.43300
ts4.l6  0.3625947  0.3215357   1.128  0.26372
ts5.l6  0.0046882  0.0033007   1.420  0.16043
ts6.l6  0.0289977  0.0402011   0.721  0.47338
ts1.l7 -0.2820099  0.5833555  -0.483  0.63047
ts2.l7  0.2033183  0.1267729   1.604  0.11376
ts3.l7  0.0533235  0.1632825   0.327  0.74507
ts4.l7  0.6368697  0.3337218   1.908  0.06090 .
ts5.l7 -0.0007831  0.0030581  -0.256  0.79874
ts6.l7  0.0682590  0.0371632   1.837  0.07097 .
ts1.l8  0.4824547  0.5160654   0.935  0.35342
ts2.l8 -0.1014239  0.1244822  -0.815  0.41828
ts3.l8 -0.0111756  0.1566007  -0.071  0.94333
ts4.l8  0.0666626  0.3041511   0.219  0.82722
ts5.l8  0.0005343  0.0024624   0.217  0.82892
ts6.l8 -0.0622793  0.0355182  -1.753  0.08439 .
const   0.3379266  0.2616079   1.292  0.20117
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.18 on 63 degrees of freedom
```

```
Multiple R-Squared: 0.6628,     Adjusted R-squared: 0.406
F-statistic:  2.58 on 48 and 63 DF,  p-value: 0.0002283


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -6.604e-01  2.161e-01  -3.057 0.003280 **
ts2.l1 -7.504e-02  5.900e-02  -1.272 0.208077
ts3.l1 -2.625e-01  7.110e-02  -3.692 0.000467 ***
ts4.l1 -3.571e-01  1.463e-01  -2.440 0.017497 *
ts5.l1  4.593e-03  1.011e-03   4.542 2.58e-05 ***
ts6.l1  1.378e-02  1.768e-02   0.780 0.438570
ts1.l2  1.900e-01  2.509e-01   0.757 0.451838
ts2.l2  1.358e-01  6.118e-02   2.220 0.030052 *
ts3.l2  1.740e-01  7.794e-02   2.233 0.029131 *
ts4.l2  2.349e-01  1.526e-01   1.539 0.128691
ts5.l2  5.182e-03  1.353e-03   3.829 0.000299 ***
ts6.l2 -1.219e-02  1.841e-02  -0.662 0.510561
ts1.l3 -4.195e-01  2.600e-01  -1.614 0.111599
ts2.l3 -2.317e-02  6.995e-02  -0.331 0.741600
ts3.l3  1.949e-02  8.717e-02   0.224 0.823757
ts4.l3 -4.530e-02  1.651e-01  -0.274 0.784747
ts5.l3  2.854e-03  1.585e-03   1.801 0.076514 .
ts6.l3  3.606e-02  1.857e-02   1.942 0.056619 .
ts1.l4  5.691e-01  2.664e-01   2.136 0.036563 *
ts2.l4 -1.151e-01  7.543e-02  -1.526 0.131948
ts3.l4 -1.009e-01  8.072e-02  -1.250 0.215845
ts4.l4 -2.302e-01  1.548e-01  -1.486 0.142156
ts5.l4  3.183e-03  1.644e-03   1.937 0.057258 .
ts6.l4 -4.774e-02  1.964e-02  -2.431 0.017909 *
ts1.l5  8.159e-02  2.891e-01   0.282 0.778739
ts2.l5  3.875e-02  6.579e-02   0.589 0.557979
ts3.l5 -1.158e-01  8.174e-02  -1.417 0.161493
ts4.l5 -1.606e-01  1.542e-01  -1.041 0.301674
ts5.l5  1.890e-03  1.644e-03   1.150 0.254530
ts6.l5  8.140e-04  2.010e-02   0.041 0.967818
ts1.l6 -6.167e-01  2.930e-01  -2.105 0.039315 *
ts2.l6  9.863e-02  6.475e-02   1.523 0.132672
ts3.l6  3.402e-02  8.294e-02   0.410 0.683094
ts4.l6 -1.319e-01  1.574e-01  -0.838 0.405402
ts5.l6 -8.530e-04  1.616e-03  -0.528 0.599514
ts6.l6  5.265e-03  1.969e-02   0.267 0.790008
ts1.l7  4.386e-01  2.857e-01   1.535 0.129710
ts2.l7 -7.969e-02  6.208e-02  -1.284 0.203921
ts3.l7  4.159e-02  7.996e-02   0.520 0.604771
ts4.l7 -1.462e-02  1.634e-01  -0.089 0.928981
ts5.l7 -2.419e-06  1.497e-03  -0.002 0.998716
ts6.l7 -1.855e-02  1.820e-02  -1.019 0.311904
ts1.l8 -2.756e-01  2.527e-01  -1.090 0.279669
ts2.l8  8.396e-02  6.096e-02   1.377 0.173268
ts3.l8  5.434e-02  7.668e-02   0.709 0.481183
ts4.l8  1.344e-01  1.489e-01   0.903 0.370123
ts5.l8  9.899e-04  1.206e-03   0.821 0.414780
ts6.l8  2.300e-02  1.739e-02   1.323 0.190740
const  -7.036e-02  1.281e-01  -0.549 0.584778
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5778 on 63 degrees of freedom
Multiple R-Squared: 0.6891,     Adjusted R-squared: 0.4522
F-statistic: 2.909 on 48 and 63 DF,  p-value: 4.108e-05
```

```
Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  32.821601  27.033668   1.214  0.22924
ts2.l1  -7.535064   7.382412  -1.021  0.31131
ts3.l1  -4.901373   8.896192  -0.551  0.58362
ts4.l1 -28.279361  18.307885  -1.545  0.12744
ts5.l1  -0.715936   0.126522  -5.659    4e-07 ***
ts6.l1  -1.911617   2.212377  -0.864  0.39084
ts1.l2 -10.316124  31.397584  -0.329  0.74357
ts2.l2  -0.744272   7.654756  -0.097  0.92285
ts3.l2  -9.517544   9.752789  -0.976  0.33286
ts4.l2 -26.782217  19.087838  -1.403  0.16550
ts5.l2  -0.518616   0.169346  -3.062  0.00323 **
ts6.l2  -1.342462   2.304108  -0.583  0.56222
ts1.l3 -39.274415  32.531121  -1.207  0.23183
ts2.l3  16.461617   8.752257   1.881  0.06462 .
ts3.l3  10.636012  10.906657   0.975  0.33320
ts4.l3   9.670365  20.661584   0.468  0.64137
ts5.l3  -0.315262   0.198294  -1.590  0.11687
ts6.l3   3.705391   2.323138   1.595  0.11572
ts1.l4 -16.773062  33.337720  -0.503  0.61663
ts2.l4 -11.905202   9.438200  -1.261  0.21182
ts3.l4  -7.586657  10.100592  -0.751  0.45538
ts4.l4  -4.201211  19.374262  -0.217  0.82903
ts5.l4  -0.035127   0.205649  -0.171  0.86492
ts6.l4  -0.898736   2.457151  -0.366  0.71577
ts1.l5  24.980211  36.179131   0.690  0.49244
ts2.l5   0.268073   8.231459   0.033  0.97412
ts3.l5   7.462809  10.227052   0.730  0.46827
ts4.l5  18.674524  19.291855   0.968  0.33675
ts5.l5   0.062026   0.205664   0.302  0.76396
ts6.l5  -0.947200   2.514567  -0.377  0.70767
ts1.l6   1.468969  36.665682   0.040  0.96817
ts2.l6   8.156117   8.101237   1.007  0.31789
ts3.l6  -2.270087  10.377414  -0.219  0.82755
ts4.l6 -32.350416  19.700624  -1.642  0.10555
ts5.l6  -0.001018   0.202233  -0.005  0.99600
ts6.l6   3.019005   2.463135   1.226  0.22488
ts1.l7 -35.046546  35.742430  -0.981  0.33057
ts2.l7   0.113709   7.767430   0.015  0.98837
ts3.l7 -10.646313  10.004385  -1.064  0.29132
ts4.l7   4.647118  20.447272   0.227  0.82095
ts5.l7   0.291681   0.187372   1.557  0.12455
ts6.l7  -1.695982   2.277006  -0.745  0.45914
ts1.l8  56.023073  31.619541   1.772  0.08127 .
ts2.l8  -0.099078   7.627075  -0.013  0.98968
ts3.l8  -5.057765   9.594990  -0.527  0.59996
ts4.l8   3.962720  18.635465   0.213  0.83229
ts5.l8   0.035074   0.150872   0.232  0.81692
ts6.l8  -0.494233   2.176216  -0.227  0.82108
const    1.440807  16.028825   0.090  0.92866
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 72.3 on 63 degrees of freedom
Multiple R-Squared: 0.6379,     Adjusted R-squared: 0.3621
F-statistic: 2.313 on 48 and 63 DF,  p-value: 0.0009478


Estimation results for equation ts6:
====================================
```

```
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -1.2293446  1.6530222  -0.744   0.4598
ts2.l1  0.0007628  0.4514108   0.002   0.9987
ts3.l1 -0.2504653  0.5439737  -0.460   0.6468
ts4.l1 -0.1770179  1.1194686  -0.158   0.8749
ts5.l1 -0.0079054  0.0077364  -1.022   0.3108
ts6.l1  0.3103586  0.1352797   2.294   0.0251 *
ts1.l2  0.6311613  1.9198617   0.329   0.7434
ts2.l2  1.1230868  0.4680638   2.399   0.0194 *
ts3.l2  1.2723178  0.5963518   2.134   0.0368 *
ts4.l2  0.3478962  1.1671602   0.298   0.7666
ts5.l2 -0.0067309  0.0103549  -0.650   0.5180
ts6.l2 -0.0605006  0.1408888  -0.429   0.6691
ts1.l3 -1.0904248  1.9891739  -0.548   0.5855
ts2.l3 -0.0556761  0.5351725  -0.104   0.9175
ts3.l3 -0.8555631  0.6669071  -1.283   0.2042
ts4.l3 -1.3537068  1.2633897  -1.071   0.2880
ts5.l3 -0.0061007  0.0121251  -0.503   0.6166
ts6.l3  0.1425150  0.1420525   1.003   0.3196
ts1.l4  1.4591287  2.0384948   0.716   0.4768
ts2.l4 -0.0770539  0.5771157  -0.134   0.8942
ts3.l4 -0.7536060  0.6176189  -1.220   0.2269
ts4.l4 -0.6162567  1.1846741  -0.520   0.6048
ts5.l4 -0.0019804  0.0125748  -0.157   0.8754
ts6.l4 -0.1046583  0.1502469  -0.697   0.4886
ts1.l5 -0.6576626  2.2122380  -0.297   0.7672
ts2.l5  0.0877852  0.5033273   0.174   0.8621
ts3.l5  0.3905925  0.6253515   0.625   0.5345
ts4.l5  1.1187548  1.1796351   0.948   0.3466
ts5.l5  0.0001960  0.0125757   0.016   0.9876
ts6.l5  0.0291660  0.1537577   0.190   0.8502
ts1.l6  0.3196639  2.2419890   0.143   0.8871
ts2.l6 -0.5319242  0.4953647  -1.074   0.2870
ts3.l6  0.3735680  0.6345456   0.589   0.5582
ts4.l6 -0.0524203  1.2046301  -0.044   0.9654
ts5.l6  0.0004142  0.0123659   0.033   0.9734
ts6.l6  0.0842294  0.1506128   0.559   0.5780
ts1.l7  2.4135478  2.1855351   1.104   0.2737
ts2.l7 -0.4375741  0.4749535  -0.921   0.3604
ts3.l7 -0.5854969  0.6117361  -0.957   0.3422
ts4.l7 -0.5107655  1.2502852  -0.409   0.6843
ts5.l7 -0.0089175  0.0114572  -0.778   0.4393
ts6.l7 -0.1444436  0.1392316  -1.037   0.3035
ts1.l8 -1.8050282  1.9334337  -0.934   0.3541
ts2.l8  0.0699947  0.4663712   0.150   0.8812
ts3.l8  0.6028339  0.5867029   1.027   0.3081
ts4.l8 -0.2138626  1.1394990  -0.188   0.8517
ts5.l8 -0.0151946  0.0092253  -1.647   0.1045
ts6.l8 -0.0334160  0.1330687  -0.251   0.8025
const  -0.5054263  0.9801113  -0.516   0.6079
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.421 on 63 degrees of freedom
Multiple R-Squared: 0.431,      Adjusted R-squared: -0.002592
F-statistic: 0.994 on 48 and 63 DF,  p-value: 0.5039



Covariance matrix of residuals:
        ts1     ts2      ts3      ts4       ts5      ts6
ts1  0.15073  0.1485   0.1092  0.01212   -6.5221   0.2990
ts2  0.14846  1.6742   0.1149 -0.17243   -9.8369  -1.0350
```

```
ts3  0.10916  0.1149   1.3925 -0.26579  -10.1710  -0.5622
ts4  0.01212 -0.1724  -0.2658  0.33391   -0.2102  -0.2496
ts5 -6.52208 -9.8369 -10.1710 -0.21022 5227.6613 -25.0753
ts6  0.29901 -1.0350  -0.5622 -0.24961  -25.0753  19.5459

Correlation matrix of residuals:
         ts1      ts2      ts3       ts4       ts5      ts6
ts1  1.00000  0.29554  0.23827  0.054045 -0.232344  0.17420
ts2  0.29554  1.00000  0.07523 -0.230618 -0.105148 -0.18093
ts3  0.23827  0.07523  1.00000 -0.389787 -0.119208 -0.10775
ts4  0.05404 -0.23062 -0.38979  1.000000 -0.005032 -0.09770
ts5 -0.23234 -0.10515 -0.11921 -0.005032  1.000000 -0.07844
ts6  0.17420 -0.18093 -0.10775 -0.097704 -0.078445  1.00000


> save.image("C:\\Users\\minhas01\\Desktop\\Nahayan Minhas\\Workspace main")
> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> HQC <- summary(var_model)$criteria['HQ']
> cat("AIC:", AIC, "\n")
AIC: 3082.242
> cat("BIC:", BIC, "\n")
BIC: 3881.481
> cat("HQC:", HQC, "\n")
HQC:
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))num_parameters <- length(coef(var_model))
Error: unexpected symbol in "num_parameters <- length(coef(var_model))num_parameters"
> num_parameters <- length(coef(var_model))
> num_observations <- length(var_model$y)/ncol(var_model$y)
> residual_variance <- as.numeric(-2 * log_likelihood / num_observations)
> HQC <- log(residual_variance) + (2 * log(log(num_observations)) * num_parameters) / num_observa
tions
> cat("HQC:", HQC, "\n")
HQC: 3.190849
> num_observations <- nobs(var_model)
Error in nobs.default(var_model) : no 'nobs' method is available
> num_observations <- length(residuals(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("HQC:", HQC, "\n")
HQC: 2516.723
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("HQC:", HQC, "\n")
HQC: 2516.723
> train_set <- window(mts_data, end = c(110))
Error in window.default(x, ...) : 'start' cannot be after 'end'
> train_set <- window(mts_data, start=c(1994, 1), end=c(2020, 4)
+
+
+
+ aaaaa
Error: unexpected symbol in:
"
aaaaa"
> train_set <- window(mts_data, start=c(1994, 1), end=c(2020, 4)
+ test_set <- window(mts_data, start=c(2021, 1), end=c(2023, 4)
Error: unexpected symbol in:
"train_set <- window(mts_data, start=c(1994, 1), end=c(2020, 4)
test_set"
> train_set <- window(mts_data, start=c(1994,1), end=c(2020,4))
Warning message:
In window.default(x, ...) : 'start' value not changed
> library(vars)
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(f) f$fcst)
Error in f$fcst : $ operator is invalid for atomic vectors
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, `[[`, "mean")
Error in FUN(X[[i]], ...) : subscript out of bounds
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
```

```
> actual_values <- as.matrix(test_set)
Error: object 'test_set' not found
> test_set <- window(mts_data, start=c(2021,1), end=c(2023,4))
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> MAPE <- colMeans(abs((actual_values - forecasted_values)/actual_values)) * 100
> cat("RMSE:", RMSE, "\n")
RMSE: 0.7471908 2.856689 1.446747 1.328938 108.0238 5.661724
> cat("MAE:", MAE, "\n")
MAE: 0.5584822 2.180331 1.221535 0.8079338 81.23333 4.588206
> cat("MAPE:", MAPE, "\n")
MAPE: Inf 49.41089 149.4332 Inf 319.6007 116.1832
> forecast_times <- time(test_set)
> for (i in 1:ncol(actual_values)) {
+ ts.plot(test_set[, i], col = "black", lwd = 2,
+             ylab = paste("Variable", i), xlab = "Time",
+             main = paste("Actual vs. Forecasted for Variable", i))
+ lines(forecast_times, forecasted_values[, i], col = "red", lwd = 2)
+ legend("topleft", legend = c("Actual", "Forecasted"),
+            col = c("black", "red"), lty = 1, cex = 0.8)
+ if (interactive()) {
+         readline(prompt="Press [enter] to continue")
+     }
+ }
Error in plot.xy(xy.coords(x, y), type = type, ...) : invalid plot type
> for (i in 1:ncol(actual_values)) {
+ plot(forecast_times, type = "n", ylim = range(c(test_set[, i], forecasted_values[, i])),
+        ylab = paste("Variable", i), xlab = "Time",
+        main = paste("Actual vs. Forecasted for Variable", i))
+ lines(test_set[, i], col = "black", lwd = 2)
+ lines(forecast_times, forecasted_values[, i], col = "red", lwd = 2)
+ legend("topleft", legend = c("Actual", "Forecasted"), col = c("black", "red"), lty = 1, cex = 0
.8)
+ if (interactive()) {
+     readline(prompt="Press [enter] to continue")
+   }
+ }
Error in plot.xy(xy.coords(x, y), type = type, ...) : invalid plot type
> install.packages("stats")
Warning: package ‘stats’ is in use and will not be installed
> for (i in 1:ncol(forecasted_values)) {
+ forecast_time_index <- time(test_set)[(length(test_set) - nrow(forecasted_values) + 1):length(t
est_set)]
+ forecast_ts <- ts(forecasted_values[, i], start=start(forecast_time_index), frequency=frequency
(test_set))
+ ts.plot(test_set[, i], col = "black", lwd = 2,
+           ylab = paste("Variable", i), xlab = "Time",
+           main = paste("Actual vs. Forecasted for Variable", i))
+ lines(forecast_ts, col = "red", lwd = 2)
+ legend("topleft", legend = c("Actual", "Forecasted"), col = c("black", "red"), lty = 1, cex = 0
.8)
+ if (interactive()) {
+     readline(prompt="Press [enter] to continue")
+   }
+ }
Press [enter] to continue
Press [enter] to continue
Press [enter] to continueaaaaa
Press [enter] to continue
Press [enter] to continue
Press [enter] to continue
> for (i in 1:ncol(forecasted_values)) {
+ ts.plot(test_set[, i], col = "black", lwd = 2,
+           ylab = paste("Variable", i), xlab = "Time",
+           main = paste("Actual vs. Forecasted for Variable", i))
+ forecast_indices <- (length(test_set) - nrow(forecasted_values) + 1):length(test_set)
+ lines(forecast_indices, forecasted_values[, i], col = "red", lwd = 2)
+
+ legend("topleft", legend = c("Actual", "Forecasted"), col = c("black", "red"), lty = 1, cex = 0
```

```
.8)
+ if (interactive()) {
+     readline(prompt="Press [enter] to continue")
+   }
+ }
Press [enter] to continue
Press [enter] to continue
Press [enter] to continue
Press [enter] to continue
Press [enter] to continue
Press [enter] to continue
> par(mfrow=c(2, 1))
> for(i in 1:ncol(forecasted_values)) {
+ plot(test_set[,i], type='l', col='black', lwd=2,
+ main=paste("Actual Values for Variable", i), ylab="Value", xlab="Time")
+ plot(forecasted_values[,i], type='l', col='red', lwd=2,
+        main=paste("Forecasted Values for Variable", i), ylab="Value", xlab="Time")
+ par(mfrow=c(2, 1))
+ }
>
> par(mfrow=c(1, 1))
>
> par(mfrow=c(2, 1))
> > for(i in 1:ncol(forecasted_values)) {
Error: unexpected '>' in ">"
> + plot(test_set[,i], type='l', col='black', lwd=2,
+ + main=paste("Actual Values for Variable", i), ylab="Value", xlab="Time")
Error: unexpected '=' in:
"+ plot(test_set[,i], type='l', col='black', lwd=2,
+ main="
> + plot(forecasted_values[,i], type='l', col='red', lwd=2,
+ +        main=paste("Forecasted Values for Variable", i), ylab="Value", xlab="Time")
Error: unexpected '=' in:
"+ plot(forecasted_values[,i], type='l', col='red', lwd=2,
+        main="
> + par(mfrow=c(2, 1))
Error in +par(mfrow = c(2, 1)) : invalid argument to unary operator
> + }
Error: unexpected '}' in "+ }"
> >
Error: unexpected '>' in ">"
> > par(mfrow=c(1, 1))
Error: unexpected '>' in ">"
> var_model <- VAR(train_set, p=8)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 98
Log Likelihood: -1014.959
Roots of the characteristic polynomial:
1.094 1.094 0.9913 0.9913 0.9637 0.9637 0.9473 0.9473 0.9265 0.9265 0.9251 0.9251 0.9218 0.9218
0.92  0.92 0.9198 0.9198 0.9177 0.9177 0.9169 0.9169 0.9139 0.9139 0.8999 0.8999 0.8973 0.8973 0.
8631 0.8631 0.8561 0.8561 0.8373 0.8373 0.8255 0.8255 0.8179 0.8179 0.8123 0.8123 0.7111 0.6886 0
.6886 0.642 0.642 0.6283 0.6283 0.3564
Call:
VAR(y = train_set, p = 8)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
```

```
ts1.l1  3.888e-01  1.620e-01   2.400   0.0202 *
ts2.l1 -5.645e-02  5.901e-02  -0.957   0.3435
ts3.l1  9.902e-02  5.621e-02   1.762   0.0844 .
ts4.l1  9.614e-02  2.971e-01   0.324   0.7476
ts5.l1  1.374e-03  7.807e-04   1.760   0.0846 .
ts6.l1  9.391e-03  1.474e-02   0.637   0.5269
ts1.l2 -1.809e-01  1.784e-01  -1.014   0.3155
ts2.l2 -5.880e-02  5.753e-02  -1.022   0.3117
ts3.l2 -1.245e-02  6.771e-02  -0.184   0.8548
ts4.l2 -3.388e-01  2.970e-01  -1.141   0.2596
ts5.l2  1.555e-03  1.058e-03   1.471   0.1477
ts6.l2 -5.677e-03  1.502e-02  -0.378   0.7071
ts1.l3 -2.115e-02  1.854e-01  -0.114   0.9097
ts2.l3 -6.714e-02  6.222e-02  -1.079   0.2858
ts3.l3 -1.527e-02  7.526e-02  -0.203   0.8401
ts4.l3  1.041e-01  3.157e-01   0.330   0.7430
ts5.l3  1.307e-03  1.181e-03   1.107   0.2738
ts6.l3 -1.979e-02  1.414e-02  -1.400   0.1678
ts1.l4  1.701e-01  1.988e-01   0.856   0.3964
ts2.l4 -5.874e-02  6.508e-02  -0.903   0.3711
ts3.l4 -4.008e-02  7.074e-02  -0.566   0.5736
ts4.l4 -1.261e-01  3.237e-01  -0.390   0.6986
ts5.l4  1.991e-03  1.247e-03   1.596   0.1170
ts6.l4 -5.549e-04  1.512e-02  -0.037   0.9709
ts1.l5 -3.929e-02  2.327e-01  -0.169   0.8666
ts2.l5 -1.914e-02  6.363e-02  -0.301   0.7648
ts3.l5  3.618e-02  7.559e-02   0.479   0.6343
ts4.l5 -2.443e-01  3.184e-01  -0.767   0.4466
ts5.l5  2.003e-03  1.270e-03   1.577   0.1212
ts6.l5 -1.418e-02  1.528e-02  -0.928   0.3578
ts1.l6  1.244e-02  2.234e-01   0.056   0.9558
ts2.l6 -8.284e-02  5.990e-02  -1.383   0.1729
ts3.l6 -5.789e-02  7.714e-02  -0.750   0.4566
ts4.l6 -2.612e-01  3.206e-01  -0.815   0.4193
ts5.l6  1.406e-03  1.266e-03   1.111   0.2722
ts6.l6 -5.797e-03  1.471e-02  -0.394   0.6952
ts1.l7  1.332e-02  2.237e-01   0.060   0.9528
ts2.l7 -2.387e-03  5.884e-02  -0.041   0.9678
ts3.l7 -2.957e-02  6.987e-02  -0.423   0.6740
ts4.l7  1.075e-01  3.251e-01   0.331   0.7423
ts5.l7 -6.405e-05  1.180e-03  -0.054   0.9569
ts6.l7 -2.630e-02  1.378e-02  -1.909   0.0621 .
ts1.l8 -2.910e-02  2.044e-01  -0.142   0.8874
ts2.l8  2.689e-02  5.596e-02   0.481   0.6330
ts3.l8 -1.117e-02  7.089e-02  -0.158   0.8754
ts4.l8 -1.370e-01  2.443e-01  -0.561   0.5777
ts5.l8  3.232e-04  9.702e-04   0.333   0.7405
ts6.l8  2.111e-03  1.371e-02   0.154   0.8782
const   2.843e-01  1.780e-01   1.597   0.1167
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3943 on 49 degrees of freedom
Multiple R-Squared: 0.5879,     Adjusted R-squared: 0.1843
F-statistic: 1.456 on 48 and 49 DF,  p-value: 0.09669


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.2772192  0.4397575   0.630  0.53137
ts2.l1 -0.1507859  0.1601658  -0.941  0.35110
ts3.l1  0.4057433  0.1525649   2.659  0.01055 *
```

```
ts4.l1  1.1368778  0.8063147   1.410  0.16487
ts5.l1 -0.0005565  0.0021192  -0.263  0.79395
ts6.l1 -0.0758518  0.0399995  -1.896  0.06382 .
ts1.l2 -1.2020952  0.4841759  -2.483  0.01651 *
ts2.l2 -0.0605471  0.1561489  -0.388  0.69988
ts3.l2 -0.0066271  0.1837769  -0.036  0.97138
ts4.l2  0.2251081  0.8062536   0.279  0.78126
ts5.l2 -0.0005438  0.0028705  -0.189  0.85053
ts6.l2  0.0178090  0.0407650   0.437  0.66412
ts1.l3  0.0654249  0.5032301   0.130  0.89709
ts2.l3  0.0520050  0.1688847   0.308  0.75944
ts3.l3  0.2149429  0.2042909   1.052  0.29790
ts4.l3  0.8573614  0.8569640   1.000  0.32200
ts5.l3  0.0013373  0.0032057   0.417  0.67837
ts6.l3 -0.0270714  0.0383704  -0.706  0.48382
ts1.l4  1.6545641  0.5396850   3.066  0.00353 **
ts2.l4 -0.2526795  0.1766595  -1.430  0.15897
ts3.l4 -0.0602645  0.1920248  -0.314  0.75498
ts4.l4 -0.8267311  0.8787425  -0.941  0.35142
ts5.l4  0.0003415  0.0033861   0.101  0.92007
ts6.l4 -0.0251445  0.0410445  -0.613  0.54296
ts1.l5 -0.1361573  0.6315640  -0.216  0.83020
ts2.l5 -0.0579167  0.1727148  -0.335  0.73881
ts3.l5 -0.0347546  0.2051902  -0.169  0.86620
ts4.l5  0.1796939  0.8641608   0.208  0.83614
ts5.l5  0.0008931  0.0034476   0.259  0.79669
ts6.l5  0.0208927  0.0414719   0.504  0.61667
ts1.l6  0.0327067  0.6064792   0.054  0.95721
ts2.l6  0.1493519  0.1625822   0.919  0.36279
ts3.l6  0.0618919  0.2093813   0.296  0.76879
ts4.l6 -0.8368070  0.8703586  -0.961  0.34105
ts5.l6  0.0021055  0.0034360   0.613  0.54286
ts6.l6 -0.0252839  0.0399239  -0.633  0.52948
ts1.l7 -0.0253028  0.6073194  -0.042  0.96694
ts2.l7 -0.2177220  0.1597082  -1.363  0.17904
ts3.l7 -0.3336727  0.1896517  -1.759  0.08475 .
ts4.l7 -0.8450244  0.8825113  -0.958  0.34300
ts5.l7  0.0002157  0.0032036   0.067  0.94660
ts6.l7 -0.0415216  0.0373952  -1.110  0.27227
ts1.l8  0.3703350  0.5548984   0.667  0.50765
ts2.l8 -0.0525210  0.1519007  -0.346  0.73100
ts3.l8  0.0516054  0.1924210   0.268  0.78968
ts4.l8  0.6608800  0.6632525   0.996  0.32394
ts5.l8 -0.0013918  0.0026335  -0.529  0.59953
ts6.l8 -0.0103010  0.0372051  -0.277  0.78304
const   1.6114561  0.4830836   3.336  0.00163 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.07 on 49 degrees of freedom
Multiple R-Squared: 0.6605,     Adjusted R-squared: 0.328
F-statistic: 1.986 on 48 and 49 DF,  p-value: 0.009174


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.5119577  0.4806638   1.065  0.29205
ts2.l1  0.2384904  0.1750644   1.362  0.17933
ts3.l1  0.4718298  0.1667565   2.829  0.00674 **
ts4.l1 -0.4042375  0.8813181  -0.459  0.64850
ts5.l1 -0.0056023  0.0023164  -2.419  0.01934 *
ts6.l1  0.0030191  0.0437203   0.069  0.94523
```

```
ts1.l2 -0.2410915  0.5292140  -0.456  0.65072
ts2.l2 -0.2825685  0.1706739  -1.656  0.10419
ts3.l2  0.1733873  0.2008719   0.863  0.39225
ts4.l2  0.8506004  0.8812513   0.965  0.33917
ts5.l2 -0.0036700  0.0031375  -1.170  0.24777
ts6.l2  0.0401858  0.0445570   0.902  0.37152
ts1.l3  1.4919480  0.5500405   2.712  0.00919 **
ts2.l3 -0.4484613  0.1845943  -2.429  0.01883 *
ts3.l3  0.0033176  0.2232940   0.015  0.98821
ts4.l3  0.5794116  0.9366788   0.619  0.53906
ts5.l3 -0.0013277  0.0035038  -0.379  0.70638
ts6.l3 -0.0591642  0.0419397  -1.411  0.16465
ts1.l4 -1.1553367  0.5898865  -1.959  0.05587 .
ts2.l4  0.1122970  0.1930924   0.582  0.56352
ts3.l4 -0.0547100  0.2098870  -0.261  0.79544
ts4.l4 -1.2683593  0.9604831  -1.321  0.19279
ts5.l4 -0.0002296  0.0037010  -0.062  0.95079
ts6.l4  0.0460984  0.0448625   1.028  0.30921
ts1.l5 -1.1309214  0.6903121  -1.638  0.10777
ts2.l5 -0.0741047  0.1887808  -0.393  0.69636
ts3.l5  0.0516540  0.2242770   0.230  0.81881
ts4.l5  0.2417122  0.9445450   0.256  0.79910
ts5.l5  0.0035323  0.0037683   0.937  0.35317
ts6.l5 -0.0289577  0.0453296  -0.639  0.52591
ts1.l6  1.0000511  0.6628939   1.509  0.13782
ts2.l6 -0.0656989  0.1777056  -0.370  0.71319
ts3.l6  0.0550860  0.2288580   0.241  0.81079
ts4.l6  0.3791976  0.9513193   0.399  0.69192
ts5.l6  0.0068015  0.0037556   1.811  0.07627 .
ts6.l6  0.0377127  0.0436376   0.864  0.39168
ts1.l7 -0.1802712  0.6638123  -0.272  0.78709
ts2.l7  0.0315362  0.1745642   0.181  0.85738
ts3.l7 -0.1424177  0.2072931  -0.687  0.49530
ts4.l7  0.3810554  0.9646025   0.395  0.69453
ts5.l7  0.0025010  0.0035016   0.714  0.47846
ts6.l7  0.0439199  0.0408737   1.075  0.28785
ts1.l8  0.5987183  0.6065151   0.987  0.32842
ts2.l8 -0.1481914  0.1660305  -0.893  0.37646
ts3.l8  0.1165951  0.2103200   0.554  0.58185
ts4.l8  0.2410075  0.7249483   0.332  0.74097
ts5.l8  0.0035263  0.0028785   1.225  0.22642
ts6.l8 -0.0866661  0.0406659  -2.131  0.03812 *
const   0.7595119  0.5280200   1.438  0.15667
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.17 on 49 degrees of freedom
Multiple R-Squared: 0.7036,     Adjusted R-squared: 0.4133
F-statistic: 2.423 on 48 and 49 DF,  p-value: 0.001248


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.4353793  0.2078551  -2.095 0.041397 *
ts2.l1 -0.0990816  0.0757037  -1.309 0.196705
ts3.l1 -0.2971111  0.0721111  -4.120 0.000145 ***
ts4.l1  0.1268702  0.3811114   0.333 0.740633
ts5.l1  0.0041293  0.0010017   4.122 0.000144 ***
ts6.l1  0.0062610  0.0189061   0.331 0.741933
ts1.l2  0.1015347  0.2288498   0.444 0.659232
ts2.l2  0.1603727  0.0738051   2.173 0.034650 *
ts3.l2  0.2034917  0.0868637   2.343 0.023252 *
```

```
ts4.l2  0.5022207  0.3810825   1.318 0.193672
ts5.l2  0.0040661  0.0013568   2.997 0.004272 **
ts6.l2 -0.0055761  0.0192679  -0.289 0.773498
ts1.l3 -0.3840651  0.2378559  -1.615 0.112798
ts2.l3 -0.0147841  0.0798248  -0.185 0.853832
ts3.l3  0.0658622  0.0965598   0.682 0.498395
ts4.l3 -0.1717089  0.4050512  -0.424 0.673480
ts5.l3  0.0022691  0.0015152   1.498 0.140653
ts6.l3  0.0354104  0.0181361   1.952 0.056606 .
ts1.l4  0.7361307  0.2550867   2.886 0.005791 **
ts2.l4 -0.2001837  0.0834996  -2.397 0.020368 *
ts3.l4 -0.0944939  0.0907621  -1.041 0.302932
ts4.l4 -0.4576574  0.4153450  -1.102 0.275900
ts5.l4  0.0026731  0.0016004   1.670 0.101252
ts6.l4 -0.0357749  0.0194000  -1.844 0.071224 .
ts1.l5  0.2065767  0.2985140   0.692 0.492193
ts2.l5 -0.0176911  0.0816351  -0.217 0.829334
ts3.l5 -0.1905154  0.0969849  -1.964 0.055171 .
ts4.l5 -0.8066930  0.4084528  -1.975 0.053917 .
ts5.l5  0.0015098  0.0016295   0.926 0.358730
ts6.l5 -0.0237373  0.0196020  -1.211 0.231718
ts1.l6 -0.6074479  0.2866575  -2.119 0.039177 *
ts2.l6  0.0500911  0.0768459   0.652 0.517551
ts3.l6 -0.0598851  0.0989659  -0.605 0.547899
ts4.l6  0.8268062  0.4113823   2.010 0.049973 *
ts5.l6 -0.0012275  0.0016240  -0.756 0.453388
ts6.l6 -0.0033739  0.0188704  -0.179 0.858836
ts1.l7  0.4823234  0.2870546   1.680 0.099274 .
ts2.l7  0.0568832  0.0754874   0.754 0.454728
ts3.l7  0.2136873  0.0896404   2.384 0.021052 *
ts4.l7  0.8302606  0.4171264   1.990 0.052137 .
ts5.l7 -0.0001368  0.0015142  -0.090 0.928363
ts6.l7  0.0007237  0.0176752   0.041 0.967506
ts1.l8 -0.0447484  0.2622774  -0.171 0.865229
ts2.l8  0.0872184  0.0717972   1.215 0.230268
ts3.l8  0.0580298  0.0909494   0.638 0.526415
ts4.l8 -0.1656471  0.3134919  -0.528 0.599611
ts5.l8  0.0005543  0.0012448   0.445 0.658073
ts6.l8  0.0361394  0.0175853   2.055 0.045221 *
const   0.0413252  0.2283335   0.181 0.857125
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5058 on 49 degrees of freedom
Multiple R-Squared: 0.7648,     Adjusted R-squared: 0.5344
F-statistic: 3.319 on 48 and 49 DF,  p-value: 2.565e-05


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  22.103024  29.654221   0.745   0.4596
ts2.l1   4.355831  10.800480   0.403   0.6885
ts3.l1  -2.646260  10.287928  -0.257   0.7981
ts4.l1 -31.641276  54.372311  -0.582   0.5633
ts5.l1  -0.795820   0.142907  -5.569 1.07e-06 ***
ts6.l1  -0.321302   2.697294  -0.119   0.9057
ts1.l2 -17.619879  32.649491  -0.540   0.5919
ts2.l2   9.324108  10.529608   0.886   0.3802
ts3.l2 -15.543638  12.392652  -1.254   0.2157
ts4.l2 -70.043450  54.368190  -1.288   0.2037
ts5.l2  -0.489705   0.193565  -2.530   0.0147 *
ts6.l2   1.847834   2.748914   0.672   0.5046
```

```
ts1.l3 -38.212653  33.934372  -1.126   0.2656
ts2.l3  20.077931  11.388419   1.763   0.0841 .
ts3.l3   4.247677  13.775972   0.308   0.7591
ts4.l3 -15.718776  57.787751  -0.272   0.7868
ts5.l3  -0.234119   0.216167  -1.083   0.2841
ts6.l3   2.613557   2.587438   1.010   0.3174
ts1.l4 -17.774213  36.392644  -0.488   0.6274
ts2.l4 -20.051622  11.912703  -1.683   0.0987 .
ts3.l4 -15.713108  12.948832  -1.213   0.2308
ts4.l4  27.195589  59.256342   0.459   0.6483
ts5.l4   0.066064   0.228333   0.289   0.7735
ts6.l4  -1.342280   2.767761  -0.485   0.6299
ts1.l5  17.795550  42.588329   0.418   0.6779
ts2.l5  -0.850904  11.646700  -0.073   0.9421
ts3.l5   6.935349  13.836617   0.501   0.6185
ts4.l5  70.184807  58.273053   1.204   0.2342
ts5.l5   0.190401   0.232482   0.819   0.4168
ts6.l5   0.093683   2.796578   0.033   0.9734
ts1.l6 -11.088090  40.896780  -0.271   0.7874
ts2.l6   7.816160  10.963427   0.713   0.4793
ts3.l6   6.378182  14.119237   0.452   0.6535
ts4.l6 -85.934898  58.690992  -1.464   0.1495
ts5.l6   0.126141   0.231699   0.544   0.5886
ts6.l6   2.553165   2.692192   0.948   0.3476
ts1.l7 -43.059326  40.953440  -1.051   0.2982
ts2.l7  -5.874419  10.769621  -0.545   0.5879
ts3.l7  -8.647705  12.788802  -0.676   0.5021
ts4.l7  40.108814  59.510488   0.674   0.5035
ts5.l7   0.224537   0.216027   1.039   0.3037
ts6.l7  -1.930724   2.521677  -0.766   0.4476
ts1.l8  83.100294  37.418532   2.221   0.0310 *
ts2.l8  -8.296082  10.243140  -0.810   0.4219
ts3.l8  -6.092281  12.975550  -0.470   0.6408
ts4.l8  28.601288  44.725185   0.639   0.5255
ts5.l8   0.008444   0.177587   0.048   0.9623
ts6.l8  -0.847643   2.508855  -0.338   0.7369
const    4.674013  32.575834   0.143   0.8865
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 72.17 on 49 degrees of freedom
Multiple R-Squared: 0.6617,     Adjusted R-squared: 0.3303
F-statistic: 1.997 on 48 and 49 DF,  p-value: 0.008744


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + ts1.
l8 + ts2.l8 + ts3.l8 + ts4.l8 + ts5.l8 + ts6.l8 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.944115   1.736076  -0.544  0.58903
ts2.l1  0.316332   0.632303   0.500  0.61911
ts3.l1  0.205208   0.602296   0.341  0.73478
ts4.l1  6.054055   3.183172   1.902  0.06307 .
ts5.l1 -0.010638   0.008366  -1.272  0.20954
ts6.l1  0.426197   0.157910   2.699  0.00952 **
ts1.l2  1.024999   1.911431   0.536  0.59421
ts2.l2  0.871818   0.616445   1.414  0.16361
ts3.l2  0.777524   0.725515   1.072  0.28911
ts4.l2 -4.592783   3.182931  -1.443  0.15540
ts5.l2 -0.002925   0.011332  -0.258  0.79741
ts6.l2 -0.049909   0.160932  -0.310  0.75778
ts1.l3 -1.234249   1.986654  -0.621  0.53730
ts2.l3  0.422228   0.666723   0.633  0.52949
ts3.l3 -0.134983   0.806500  -0.167  0.86777
```

```
ts4.l3 -0.586096   3.383126  -0.173  0.86318
ts5.l3 -0.013575   0.012655  -1.073  0.28868
ts6.l3  0.091993   0.151479   0.607  0.54646
ts1.l4  0.240225   2.130571   0.113  0.91069
ts2.l4 -0.496170   0.697417  -0.711  0.48019
ts3.l4 -0.882343   0.758076  -1.164  0.25009
ts4.l4 -1.582409   3.469103  -0.456  0.65030
ts5.l4 -0.004096   0.013367  -0.306  0.76056
ts6.l4 -0.024946   0.162036  -0.154  0.87828
ts1.l5  0.609047   2.493291   0.244  0.80804
ts2.l5 -0.277880   0.681844  -0.408  0.68539
ts3.l5 -0.160250   0.810051  -0.198  0.84400
ts4.l5  2.109558   3.411537   0.618  0.53920
ts5.l5  0.005717   0.013610   0.420  0.67628
ts6.l5 -0.016326   0.163723  -0.100  0.92097
ts1.l6 -0.602654   2.394261  -0.252  0.80232
ts2.l6 -0.484064   0.641843  -0.754  0.45435
ts3.l6  0.617308   0.826596   0.747  0.45875
ts4.l6 -3.524934   3.436005  -1.026  0.30999
ts5.l6  0.006403   0.013565   0.472  0.63899
ts6.l6  0.039240   0.157612   0.249  0.80443
ts1.l7  0.722014   2.397578   0.301  0.76458
ts2.l7 -0.684562   0.630497  -1.086  0.28290
ts3.l7 -0.474010   0.748708  -0.633  0.52961
ts4.l7  4.388731   3.483981   1.260  0.21375
ts5.l7 -0.006961   0.012647  -0.550  0.58457
ts6.l7 -0.163340   0.147629  -1.106  0.27395
ts1.l8  0.027887   2.190630   0.013  0.98989
ts2.l8 -0.089745   0.599674  -0.150  0.88165
ts3.l8  0.717322   0.759640   0.944  0.34965
ts4.l8 -3.369816   2.618391  -1.287  0.20415
ts5.l8 -0.014468   0.010397  -1.392  0.17033
ts6.l8 -0.044903   0.146878  -0.306  0.76112
const  -0.058494   1.907119  -0.031  0.97566
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.225 on 49 degrees of freedom
Multiple R-Squared: 0.5295,     Adjusted R-squared: 0.06854
F-statistic: 1.149 on 48 and 49 DF,  p-value: 0.3152



Covariance matrix of residuals:
         ts1       ts2      ts3       ts4       ts5      ts6
ts1  0.15545  0.060102   0.1058  0.029054   -6.4796   0.2663
ts2  0.06010  1.145312  -0.1839  0.006626    3.1475  -1.8510
ts3  0.10578 -0.183950   1.3683 -0.184275  -10.7013  -0.8301
ts4  0.02905  0.006626  -0.1843  0.255869    0.7299  -0.2049
ts5 -6.47956  3.147488 -10.7013  0.729924 5207.9905 -52.7097
ts6  0.26630 -1.850953  -0.8301 -0.204857  -52.7097  17.8499

Correlation matrix of residuals:
        ts1      ts2     ts3      ts4      ts5      ts6
ts1  1.0000  0.14244  0.2294  0.14568 -0.22773  0.15986
ts2  0.1424  1.00000 -0.1469  0.01224  0.04075 -0.40937
ts3  0.2294 -0.14694  1.0000 -0.31143 -0.12677 -0.16796
ts4  0.1457  0.01224 -0.3114  1.00000  0.02000 -0.09586
ts5 -0.2277  0.04075 -0.1268  0.02000  1.00000 -0.17288
ts6  0.1599 -0.40937 -0.1680 -0.09586 -0.17288  1.00000


> serial.test(var_model)

        Portmanteau Test (asymptotic)

data:  Residuals of VAR object var_model
Chi-squared = 380.62, df = 288, p-value = 0.000203
```

```
> stability(var_model)
$ts1

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


$ts2

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


$ts3

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


$ts4

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


$ts5

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


$ts6

Empirical Fluctuation Process: OLS-based CUSUM test

Call: efp(formula = formula, data = data, type = type, h = h, dynamic = dynamic,
    rescale = rescale)


> cat("AIC:", AIC, "\n")
AIC: 3082.242
> cat("MAE:", MAE, "\n")
MAE: 0.5584822 2.180331 1.221535 0.8079338 81.23333 4.588206
> cat("BIC:", BIC, "\n")
BIC: 3881.481
> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> cat("AIC:", AIC, "\n")
AIC: 2617.918
> cat("MAE:", MAE, "\n")
MAE: 0.5584822 2.180331 1.221535 0.8079338 81.23333 4.588206
> cat("BIC:", BIC, "\n")
BIC: 3377.898
> log_likelihood <- logLik(var_model)
> > num_parameters <- length(coef(var_model))
Error: unexpected '>' in ">"
> num_parameters <- length(coef(var_model))
> num_observations <- length(residuals(var_model))
>
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
```

```
> cat("HQC:", HQC, "\n")
HQC: 2052.15
> plot(stability(var_model))
> library(strucchange)
> sctest(var_model)
Error in root.matrix(J) : matrix is not positive semidefinite
> var_model <- VAR(train_set, p = 6)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 100
Log Likelihood: -1107.519
Roots of the characteristic polynomial:
1.039 1.039 0.9714 0.9714 0.9356 0.9356 0.9193 0.9193 0.8815 0.8815 0.8686 0.8638 0.8638 0.8446 0
.8446 0.8378 0.8378 0.8375 0.8375 0.8206 0.8206 0.8104 0.8104 0.7739 0.7699 0.7699 0.7671 0.7671
0.7064 0.7022 0.6313 0.6313 0.5934 0.5934 0.08558 0.02735
Call:
VAR(y = train_set, p = 6)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.3993327  0.1424386   2.804  0.00671 **
ts2.l1 -0.0368948  0.0500013  -0.738  0.46333
ts3.l1  0.0613918  0.0477061   1.287  0.20285
ts4.l1 -0.0043827  0.2493946  -0.018  0.98603
ts5.l1  0.0011343  0.0006993   1.622  0.10981
ts6.l1  0.0034892  0.0125045   0.279  0.78113
ts1.l2 -0.1669370  0.1611954  -1.036  0.30434
ts2.l2 -0.0258270  0.0511556  -0.505  0.61541
ts3.l2  0.0030604  0.0550645   0.056  0.95585
ts4.l2 -0.4101436  0.2645095  -1.551  0.12601
ts5.l2  0.0011831  0.0009436   1.254  0.21453
ts6.l2  0.0036951  0.0128900   0.287  0.77531
ts1.l3  0.0379798  0.1687013   0.225  0.82261
ts2.l3 -0.0762394  0.0498434  -1.530  0.13113
ts3.l3 -0.0308826  0.0632075  -0.489  0.62683
ts4.l3  0.0044648  0.2711599   0.016  0.98692
ts5.l3  0.0015149  0.0010809   1.401  0.16597
ts6.l3 -0.0168879  0.0125526  -1.345  0.18333
ts1.l4  0.2610010  0.1752303   1.489  0.14135
ts2.l4 -0.0539568  0.0513543  -1.051  0.29742
ts3.l4 -0.0573034  0.0608821  -0.941  0.35019
ts4.l4 -0.0257171  0.2684395  -0.096  0.92398
ts5.l4  0.0017795  0.0011127   1.599  0.11478
ts6.l4 -0.0089075  0.0129641  -0.687  0.49455
ts1.l5 -0.1895490  0.1857801  -1.020  0.31149
ts2.l5 -0.0066573  0.0513556  -0.130  0.89727
ts3.l5 -0.0017998  0.0580404  -0.031  0.97536
ts4.l5 -0.1617013  0.2600373  -0.622  0.53629
ts5.l5  0.0020698  0.0010200   2.029  0.04668 *
ts6.l5 -0.0066482  0.0121526  -0.547  0.58627
ts1.l6 -0.0035666  0.1684029  -0.021  0.98317
ts2.l6 -0.0377571  0.0475724  -0.794  0.43036
ts3.l6 -0.0036133  0.0589233  -0.061  0.95130
ts4.l6 -0.0508250  0.2188595  -0.232  0.81711
ts5.l6  0.0016055  0.0008002   2.006  0.04912 *
ts6.l6 -0.0068688  0.0114845  -0.598  0.55192
const   0.2045831  0.1312636   1.559  0.12411
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 0.3758 on 63 degrees of freedom
Multiple R-Squared: 0.5224,     Adjusted R-squared: 0.2495
F-statistic: 1.914 on 36 and 63 DF,  p-value: 0.0119


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.3516867  0.4046050   0.869  0.38803
ts2.l1 -0.1123494  0.1420315  -0.791  0.43190
ts3.l1  0.3711596  0.1355119   2.739  0.00801 **
ts4.l1  0.4735754  0.7084198   0.668  0.50626
ts5.l1 -0.0003239  0.0019865  -0.163  0.87099
ts6.l1 -0.0657810  0.0355197  -1.852  0.06872 .
ts1.l2 -1.2662786  0.4578848  -2.765  0.00745 **
ts2.l2 -0.0361196  0.1453103  -0.249  0.80450
ts3.l2 -0.0066108  0.1564138  -0.042  0.96642
ts4.l2 -0.1936674  0.7513546  -0.258  0.79743
ts5.l2 -0.0008519  0.0026804  -0.318  0.75167
ts6.l2  0.0331385  0.0366147   0.905  0.36888
ts1.l3  0.2375565  0.4792058   0.496  0.62181
ts2.l3  0.1057892  0.1415832   0.747  0.45773
ts3.l3  0.1671209  0.1795446   0.931  0.35551
ts4.l3  0.6716619  0.7702456   0.872  0.38651
ts5.l3  0.0019686  0.0030705   0.641  0.52377
ts6.l3 -0.0249910  0.0356563  -0.701  0.48596
ts1.l4  1.5463912  0.4977518   3.107  0.00284 **
ts2.l4 -0.2157977  0.1458750  -1.479  0.14403
ts3.l4 -0.2022837  0.1729391  -1.170  0.24654
ts4.l4 -0.6206363  0.7625179  -0.814  0.41875
ts5.l4  0.0013717  0.0031608   0.434  0.66578
ts6.l4 -0.0227435  0.0368254  -0.618  0.53906
ts1.l5 -0.0941702  0.5277193  -0.178  0.85894
ts2.l5  0.0521765  0.1458786   0.358  0.72179
ts3.l5  0.0059451  0.1648671   0.036  0.97135
ts4.l5  0.3302946  0.7386510   0.447  0.65629
ts5.l5  0.0017194  0.0028974   0.593  0.55502
ts6.l5  0.0161644  0.0345203   0.468  0.64122
ts1.l6 -0.2407568  0.4783581  -0.503  0.61651
ts2.l6  0.1638016  0.1351322   1.212  0.22998
ts3.l6  0.0742198  0.1673752   0.443  0.65897
ts4.l6 -0.1873444  0.6216831  -0.301  0.76414
ts5.l6  0.0018468  0.0022730   0.812  0.41958
ts6.l6 -0.0196942  0.0326224  -0.604  0.54821
const   0.9723899  0.3728619   2.608  0.01136 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.068 on 63 degrees of freedom
Multiple R-Squared: 0.5662,     Adjusted R-squared: 0.3183
F-statistic: 2.284 on 36 and 63 DF,  p-value: 0.00202


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.6302660  0.4295291   1.467 0.147258
```

```
ts2.l1  0.2466693  0.1507808   1.636 0.106838
ts3.l1  0.5113840  0.1438596   3.555 0.000724 ***
ts4.l1  0.2811282  0.7520592   0.374 0.709800
ts5.l1 -0.0046679  0.0021089  -2.213 0.030497 *
ts6.l1  0.0078489  0.0377077   0.208 0.835783
ts1.l2 -0.1512031  0.4860909  -0.311 0.756782
ts2.l2 -0.2976059  0.1542616  -1.929 0.058209 .
ts3.l2  0.1374093  0.1660491   0.828 0.411065
ts4.l2  0.5810524  0.7976388   0.728 0.469028
ts5.l2 -0.0034088  0.0028455  -1.198 0.235419
ts6.l2  0.0274209  0.0388702   0.705 0.483132
ts1.l3  1.4970026  0.5087254   2.943 0.004550 **
ts2.l3 -0.4664646  0.1503049  -3.103 0.002863 **
ts3.l3  0.0067850  0.1906047   0.036 0.971716
ts4.l3  0.5360291  0.8176935   0.656 0.514508
ts5.l3 -0.0013435  0.0032596  -0.412 0.681621
ts6.l3 -0.0570899  0.0378528  -1.508 0.136500
ts1.l4 -1.0493630  0.5284138  -1.986 0.051403 .
ts2.l4  0.0943631  0.1548610   0.609 0.544490
ts3.l4 -0.0388996  0.1835923  -0.212 0.832884
ts4.l4 -0.7108420  0.8094898  -0.878 0.383207
ts5.l4  0.0001430  0.0033555   0.043 0.966139
ts6.l4  0.0386814  0.0390939   0.989 0.326228
ts1.l5 -0.9172519  0.5602274  -1.637 0.106557
ts2.l5 -0.0281823  0.1548648  -0.182 0.856183
ts3.l5  0.1631116  0.1750231   0.932 0.354924
ts4.l5  0.6342832  0.7841527   0.809 0.421630
ts5.l5  0.0017775  0.0030759   0.578 0.565418
ts6.l5 -0.0358875  0.0366468  -0.979 0.331186
ts1.l6  1.1836405  0.5078255   2.331 0.022978 *
ts2.l6 -0.1959234  0.1434565  -1.366 0.176879
ts3.l6  0.0008319  0.1776857   0.005 0.996279
ts4.l6  0.1863819  0.6599794   0.282 0.778558
ts5.l6  0.0042649  0.0024131   1.767 0.082003 .
ts6.l6  0.0365702  0.0346319   1.056 0.295015
const   0.7883349  0.3958305   1.992 0.050755 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.133 on 63 degrees of freedom
Multiple R-Squared: 0.643,      Adjusted R-squared: 0.4391
F-statistic: 3.153 on 36 and 63 DF,  p-value: 3.248e-05


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.5888588  0.1974809  -2.982 0.004070 **
ts2.l1 -0.0850125  0.0693232  -1.226 0.224642
ts3.l1 -0.2395710  0.0661411  -3.622 0.000584 ***
ts4.l1  0.3511968  0.3457677   1.016 0.313657
ts5.l1  0.0036703  0.0009696   3.785 0.000345 ***
ts6.l1  0.0050300  0.0173365   0.290 0.772662
ts1.l2  0.1479508  0.2234858   0.662 0.510376
ts2.l2  0.1715084  0.0709235   2.418 0.018500 *
ts3.l2  0.2288847  0.0763430   2.998 0.003885 **
ts4.l2  0.5470340  0.3667235   1.492 0.140774
ts5.l2  0.0043816  0.0013083   3.349 0.001372 **
ts6.l2  0.0032691  0.0178710   0.183 0.855441
ts1.l3 -0.4010107  0.2338923  -1.715 0.091351 .
ts2.l3  0.0160928  0.0691044   0.233 0.816612
ts3.l3 -0.0011818  0.0876327  -0.013 0.989282
ts4.l3 -0.1031242  0.3759438  -0.274 0.784746
ts5.l3  0.0025029  0.0014987   1.670 0.099858 .
```

```
ts6.l3  0.0272682  0.0174033   1.567 0.122160
ts1.l4  0.5978428  0.2429442   2.461 0.016614 *
ts2.l4 -0.1203163  0.0711991  -1.690 0.095999 .
ts3.l4 -0.0248111  0.0844087  -0.294 0.769770
ts4.l4 -0.4544397  0.3721721  -1.221 0.226618
ts5.l4  0.0017579  0.0015427   1.139 0.258811
ts6.l4 -0.0327939  0.0179738  -1.825 0.072814 .
ts1.l5  0.0740184  0.2575709   0.287 0.774771
ts2.l5 -0.0293209  0.0712009  -0.412 0.681880
ts3.l5 -0.1923951  0.0804688  -2.391 0.019806 *
ts4.l5 -0.7052887  0.3605231  -1.956 0.054867 .
ts5.l5  0.0010615  0.0014142   0.751 0.455663
ts6.l5 -0.0067378  0.0168488  -0.400 0.690583
ts1.l6 -0.3716870  0.2334785  -1.592 0.116401
ts2.l6  0.0754668  0.0659557   1.144 0.256868
ts3.l6  0.0156771  0.0816930   0.192 0.848436
ts4.l6  0.3503245  0.3034330   1.155 0.252641
ts5.l6 -0.0010830  0.0011094  -0.976 0.332695
ts6.l6  0.0025153  0.0159224   0.158 0.874982
const   0.0314753  0.1819876   0.173 0.863243
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5211 on 63 degrees of freedom
Multiple R-Squared: 0.6791,     Adjusted R-squared: 0.4958
F-statistic: 3.704 on 36 and 63 DF,  p-value: 2.713e-06


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  22.22439   27.15134   0.819  0.41614
ts2.l1   5.11473    9.53114   0.537  0.59341
ts3.l1  -0.65822    9.09363  -0.072  0.94253
ts4.l1 -58.49053   47.53907  -1.230  0.22313
ts5.l1  -0.79909    0.13331  -5.994 1.09e-07 ***
ts6.l1   0.09445    2.38357   0.040  0.96852
ts1.l2 -16.50234   30.72672  -0.537  0.59311
ts2.l2   7.37752    9.75117   0.757  0.45212
ts3.l2 -10.52632   10.49627  -1.003  0.31976
ts4.l2 -61.13503   50.42025  -1.213  0.22984
ts5.l2  -0.48377    0.17987  -2.690  0.00915 **
ts6.l2   0.88300    2.45706   0.359  0.72052
ts1.l3 -41.43015   32.15749  -1.288  0.20234
ts2.l3  10.33020    9.50105   1.087  0.28106
ts3.l3  -4.99547   12.04848  -0.415  0.67983
ts4.l3 -39.15288   51.68794  -0.757  0.45158
ts5.l3  -0.12359    0.20605  -0.600  0.55078
ts6.l3   2.22875    2.39275   0.931  0.35517
ts1.l4  -2.62882   33.40203  -0.079  0.93752
ts2.l4 -10.28289    9.78906  -1.050  0.29753
ts3.l4 -14.61109   11.60522  -1.259  0.21267
ts4.l4  58.34992   51.16937   1.140  0.25847
ts5.l4   0.10682    0.21211   0.504  0.61631
ts6.l4  -2.04474    2.47120  -0.827  0.41112
ts1.l5   7.47251   35.41302   0.211  0.83356
ts2.l5   5.07122    9.78930   0.518  0.60625
ts3.l5  13.19080   11.06354   1.192  0.23762
ts4.l5  93.07276   49.56776   1.878  0.06505 .
ts5.l5   0.07903    0.19443   0.406  0.68578
ts6.l5  -0.01320    2.31651  -0.006  0.99547
ts1.l6  15.26546   32.10060   0.476  0.63604
ts2.l6   5.43738    9.06815   0.600  0.55091
ts3.l6   5.08323   11.23184   0.453  0.65241
```

```
ts4.l6 -22.01262   41.71854  -0.528  0.59960
ts5.l6  -0.09027    0.15253  -0.592  0.55612
ts6.l6   1.21225    2.18915   0.554  0.58171
const  -18.56872   25.02119  -0.742  0.46077
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 71.64 on 63 degrees of freedom
Multiple R-Squared: 0.5714,     Adjusted R-squared: 0.3265
F-statistic: 2.333 on 36 and 63 DF,  p-value: 0.00159


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.446445   1.577532  -0.283   0.7781
ts2.l1  0.005009   0.553773   0.009   0.9928
ts3.l1 -0.219165   0.528353  -0.415   0.6797
ts4.l1  3.708764   2.762089   1.343   0.1842
ts5.l1 -0.016156   0.007745  -2.086   0.0410 *
ts6.l1  0.284513   0.138489   2.054   0.0441 *
ts1.l2  0.455663   1.785267   0.255   0.7994
ts2.l2  1.085992   0.566557   1.917   0.0598 .
ts3.l2  0.881482   0.609849   1.445   0.1533
ts4.l2 -3.991887   2.929490  -1.363   0.1778
ts5.l2 -0.010295   0.010451  -0.985   0.3283
ts6.l2  0.025610   0.142759   0.179   0.8582
ts1.l3 -1.050209   1.868397  -0.562   0.5760
ts2.l3  0.434230   0.552025   0.787   0.4345
ts3.l3 -0.033704   0.700034  -0.048   0.9618
ts4.l3 -1.514924   3.003144  -0.504   0.6157
ts5.l3 -0.013322   0.011972  -1.113   0.2700
ts6.l3  0.146518   0.139022   1.054   0.2959
ts1.l4  0.390153   1.940706   0.201   0.8413
ts2.l4 -0.154531   0.568758  -0.272   0.7867
ts3.l4 -0.787964   0.674280  -1.169   0.2470
ts4.l4  0.696308   2.973015   0.234   0.8156
ts5.l4 -0.006093   0.012324  -0.494   0.6228
ts6.l4 -0.055558   0.143580  -0.387   0.7001
ts1.l5  0.822663   2.057548   0.400   0.6906
ts2.l5 -0.537268   0.568772  -0.945   0.3485
ts3.l5 -0.514212   0.642808  -0.800   0.4267
ts4.l5  0.401441   2.879959   0.139   0.8896
ts5.l5  0.005965   0.011297   0.528   0.5993
ts6.l5 -0.091194   0.134593  -0.678   0.5005
ts1.l6 -0.898359   1.865091  -0.482   0.6317
ts2.l6  0.041930   0.526873   0.080   0.9368
ts3.l6  0.678195   0.652586   1.039   0.3027
ts4.l6 -2.365936   2.423908  -0.976   0.3328
ts5.l6  0.006178   0.008862   0.697   0.4883
ts6.l6  0.093337   0.127193   0.734   0.4658
const  -1.181516   1.453767  -0.813   0.4194
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.162 on 63 degrees of freedom
Multiple R-Squared: 0.4147,     Adjusted R-squared: 0.08024
F-statistic:  1.24 on 36 and 63 DF,  p-value: 0.2244



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4      ts5      ts6
```

```
ts1  0.14126  0.07200  0.06795  0.02601   -4.774   0.2707
ts2  0.07200  1.13976 -0.16257 -0.03392    7.265  -1.3727
ts3  0.06795 -0.16257  1.28450 -0.18913   -6.548  -0.5653
ts4  0.02601 -0.03392 -0.18913  0.27152   -3.267  -0.2381
ts5 -4.77351  7.26488 -6.54757 -3.26672 5132.542 -25.3430
ts6  0.27072 -1.37272 -0.56525 -0.23809  -25.343  17.3263

Correlation matrix of residuals:
        ts1      ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.17945  0.15952  0.13282 -0.17728  0.17305
ts2  0.1794  1.00000 -0.13436 -0.06098  0.09499 -0.30890
ts3  0.1595 -0.13436  1.00000 -0.32025 -0.08064 -0.11982
ts4  0.1328 -0.06098 -0.32025  1.00000 -0.08751 -0.10977
ts5 -0.1773  0.09499 -0.08064 -0.08751  1.00000 -0.08498
ts6  0.1730 -0.30890 -0.11982 -0.10977 -0.08498  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
> num_observations <- length(residuals(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("AIC:", AIC, "\n")
AIC: 2659.037
> cat("BIC:", BIC, "\n")
BIC: 3237.385
> cat("HQC:", GQC, "\n")

> cat("HQC:", HQC, "\n")
HQC: 2237.307
> plot(stability(var_model))
>
> plot(stability(var_model))

> > plot(stability(var_model))

> > var_model <- VAR(train_set, p=4)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 102
Log Likelihood: -1170.018
Roots of the characteristic polynomial:
0.8863 0.8863 0.8767 0.8767 0.8516 0.8516 0.7875 0.7875 0.7841 0.7841 0.7568 0.7568 0.7361 0.7361
 0.7163 0.6682 0.6182 0.6182 0.612 0.612 0.5685 0.5685 0.5632 0.1848
Call:
VAR(y = train_set, p = 4)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.4797857  0.1333638   3.598 0.000565 ***
ts2.l1 -0.0578105  0.0428449  -1.349 0.181196
ts3.l1  0.0743429  0.0453503   1.639 0.105230
ts4.l1  0.0640175  0.2283825   0.280 0.779993
ts5.l1  0.0012148  0.0006346   1.914 0.059304 .
ts6.l1 -0.0006399  0.0112343  -0.057 0.954728
ts1.l2 -0.1544148  0.1485713  -1.039 0.301903
ts2.l2 -0.0504768  0.0417713  -1.208 0.230588
ts3.l2 -0.0105790  0.0509044  -0.208 0.835918
ts4.l2 -0.3022957  0.2251394  -1.343 0.183313
```

```
ts5.l2  0.0009611  0.0008178   1.175 0.243515
ts6.l2 -0.0045412  0.0116445  -0.390 0.697623
ts1.l3  0.0680637  0.1515233   0.449 0.654552
ts2.l3 -0.0565972  0.0448140  -1.263 0.210423
ts3.l3 -0.0151400  0.0535943  -0.282 0.778324
ts4.l3  0.0484179  0.2282270   0.212 0.832552
ts5.l3  0.0005824  0.0008557   0.681 0.498134
ts6.l3 -0.0124449  0.0109597  -1.136 0.259682
ts1.l4  0.1596151  0.1431112   1.115 0.268181
ts2.l4 -0.0323151  0.0426247  -0.758 0.450688
ts3.l4 -0.0511891  0.0497556  -1.029 0.306789
ts4.l4 -0.0826371  0.1979312  -0.418 0.677472
ts5.l4  0.0001090  0.0007152   0.152 0.879253
ts6.l4 -0.0094814  0.0107402  -0.883 0.380098
const   0.1614949  0.0943631   1.711 0.091029 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3725 on 77 degrees of freedom
Multiple R-Squared: 0.4282,     Adjusted R-squared: 0.2499
F-statistic: 2.402 on 24 and 77 DF,  p-value: 0.002037


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.5370662  0.3609675   1.488  0.14087
ts2.l1 -0.1349416  0.1159656  -1.164  0.24817
ts3.l1  0.3691023  0.1227469   3.007  0.00356 **
ts4.l1  0.6263615  0.6181489   1.013  0.31410
ts5.l1 -0.0004986  0.0017176  -0.290  0.77236
ts6.l1 -0.0767809  0.0304073  -2.525  0.01362 *
ts1.l2 -1.2535946  0.4021287  -3.117  0.00257 **
ts2.l2 -0.0856362  0.1130598  -0.757  0.45110
ts3.l2 -0.0306416  0.1377797  -0.222  0.82459
ts4.l2  0.0200778  0.6093710   0.033  0.97380
ts5.l2 -0.0017358  0.0022135  -0.784  0.43532
ts6.l2  0.0203107  0.0315174   0.644  0.52121
ts1.l3  0.1717025  0.4101188   0.419  0.67663
ts2.l3  0.1418569  0.1212953   1.170  0.24580
ts3.l3  0.1803652  0.1450603   1.243  0.21750
ts4.l3  1.0688602  0.6177280   1.730  0.08758 .
ts5.l3  0.0005150  0.0023160   0.222  0.82461
ts6.l3 -0.0173708  0.0296640  -0.586  0.55987
ts1.l4  1.4340243  0.3873504   3.702  0.00040 ***
ts2.l4 -0.1702685  0.1153697  -1.476  0.14406
ts3.l4 -0.1178673  0.1346703  -0.875  0.38417
ts4.l4 -0.7626061  0.5357283  -1.423  0.15863
ts5.l4 -0.0001471  0.0019358  -0.076  0.93962
ts6.l4  0.0073443  0.0290700   0.253  0.80122
const   1.2144271  0.2554068   4.755 9.07e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.008 on 77 degrees of freedom
Multiple R-Squared: 0.5271,     Adjusted R-squared: 0.3797
F-statistic: 3.577 on 24 and 77 DF,  p-value: 1.141e-05


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const
```

```
        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.535703   0.414889   1.291  0.20050
ts2.l1  0.166623   0.133289   1.250  0.21505
ts3.l1  0.469442   0.141083   3.327  0.00135 **
ts4.l1 -0.015251   0.710489  -0.021  0.98293
ts5.l1 -0.003798   0.001974  -1.924  0.05805 .
ts6.l1  0.005621   0.034950   0.161  0.87265
ts1.l2  0.004915   0.462199   0.011  0.99154
ts2.l2 -0.201035   0.129949  -1.547  0.12596
ts3.l2  0.169532   0.158362   1.071  0.28772
ts4.l2  0.721785   0.700400   1.031  0.30599
ts5.l2 -0.003436   0.002544  -1.350  0.18084
ts6.l2  0.005883   0.036225   0.162  0.87142
ts1.l3  1.233313   0.471383   2.616  0.01069 *
ts2.l3 -0.334634   0.139415  -2.400  0.01880 *
ts3.l3  0.062646   0.166730   0.376  0.70815
ts4.l3  0.453315   0.710005   0.638  0.52506
ts5.l3 -0.002545   0.002662  -0.956  0.34201
ts6.l3 -0.030393   0.034095  -0.891  0.37548
ts1.l4 -0.958308   0.445213  -2.152  0.03449 *
ts2.l4  0.146455   0.132604   1.104  0.27284
ts3.l4 -0.037092   0.154788  -0.240  0.81125
ts4.l4 -0.213232   0.615756  -0.346  0.73007
ts5.l4 -0.001842   0.002225  -0.828  0.41034
ts6.l4  0.017850   0.033412   0.534  0.59472
const   0.335995   0.293560   1.145  0.25594
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.159 on 77 degrees of freedom
Multiple R-Squared: 0.5441,     Adjusted R-squared: 0.402
F-statistic: 3.828 on 24 and 77 DF,  p-value: 3.89e-06


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.5390232  0.1876856  -2.872 0.005267 **
ts2.l1 -0.0827985  0.0602965  -1.373 0.173679
ts3.l1 -0.2271005  0.0638224  -3.558 0.000643 ***
ts4.l1  0.4329284  0.3214074   1.347 0.181939
ts5.l1  0.0037736  0.0008931   4.225 6.49e-05 ***
ts6.l1  0.0030229  0.0158103   0.191 0.848872
ts1.l2  0.1686587  0.2090874   0.807 0.422357
ts2.l2  0.1013583  0.0587856   1.724 0.088684 .
ts3.l2  0.1942387  0.0716388   2.711 0.008260 **
ts4.l2  0.5608290  0.3168433   1.770 0.080677 .
ts5.l2  0.0046631  0.0011509   4.052 0.000120 ***
ts6.l2  0.0058002  0.0163875   0.354 0.724351
ts1.l3 -0.2653442  0.2132419  -1.244 0.217151
ts2.l3 -0.0361373  0.0630677  -0.573 0.568319
ts3.l3 -0.0208079  0.0754243  -0.276 0.783381
ts4.l3 -0.0914995  0.3211886  -0.285 0.776503
ts5.l3  0.0027648  0.0012042   2.296 0.024401 *
ts6.l3  0.0164019  0.0154238   1.063 0.290919
ts1.l4  0.4476005  0.2014034   2.222 0.029191 *
ts2.l4 -0.1656239  0.0599867  -2.761 0.007200 **
ts3.l4 -0.0223376  0.0700220  -0.319 0.750584
ts4.l4 -0.2876048  0.2785527  -1.032 0.305071
ts5.l4  0.0014665  0.0010065   1.457 0.149172
ts6.l4 -0.0355479  0.0151150  -2.352 0.021238 *
const   0.2289915  0.1327991   1.724 0.088658 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 0.5242 on 77 degrees of freedom
Multiple R-Squared: 0.6034,     Adjusted R-squared: 0.4797
F-statistic: 4.881 on 24 and 77 DF,  p-value: 5.353e-08


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  27.86456   24.50639   1.137   0.2591
ts2.l1   1.00957    7.87300   0.128   0.8983
ts3.l1  -4.82298    8.33339  -0.579   0.5644
ts4.l1 -50.88143   41.96666  -1.212   0.2291
ts5.l1  -0.83229    0.11661  -7.137 4.56e-10 ***
ts6.l1  -1.46154    2.06438  -0.708   0.4811
ts1.l2 -19.81451   27.30086  -0.726   0.4702
ts2.l2  14.56731    7.67573   1.898   0.0615 .
ts3.l2  -4.42326    9.35398  -0.473   0.6376
ts4.l2 -25.66520   41.37072  -0.620   0.5368
ts5.l2  -0.61851    0.15027  -4.116 9.60e-05 ***
ts6.l2   1.25707    2.13974   0.587   0.5586
ts1.l3 -51.54289   27.84332  -1.851   0.0680 .
ts2.l3  11.70394    8.23484   1.421   0.1593
ts3.l3  -0.75408    9.84827  -0.077   0.9392
ts4.l3 -28.42012   41.93809  -0.678   0.5000
ts5.l3  -0.25136    0.15724  -1.599   0.1140
ts6.l3   3.01960    2.01392   1.499   0.1379
ts1.l4   8.54014   26.29755   0.325   0.7463
ts2.l4  -5.66713    7.83255  -0.724   0.4715
ts3.l4 -10.37861    9.14288  -1.135   0.2598
ts4.l4  35.07306   36.37105   0.964   0.3379
ts5.l4  -0.01002    0.13142  -0.076   0.9395
ts6.l4  -1.02674    1.97358  -0.520   0.6044
const  -15.54829   17.33978  -0.897   0.3727
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 68.45 on 77 degrees of freedom
Multiple R-Squared: 0.5219,     Adjusted R-squared: 0.3729
F-statistic: 3.503 on 24 and 77 DF,  p-value: 1.568e-05


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.196734   1.442135   0.136  0.89185
ts2.l1  0.252990   0.463305   0.546  0.58661
ts3.l1 -0.099466   0.490398  -0.203  0.83981
ts4.l1  4.056119   2.469625   1.642  0.10458
ts5.l1 -0.015470   0.006862  -2.254  0.02701 *
ts6.l1  0.313804   0.121483   2.583  0.01169 *
ts1.l2 -0.274742   1.606582  -0.171  0.86466
ts2.l2  1.200873   0.451696   2.659  0.00954 **
ts3.l2  0.908221   0.550457   1.650  0.10303
ts4.l2 -3.115066   2.434555  -1.280  0.20456
ts5.l2 -0.015311   0.008843  -1.731  0.08739 .
ts6.l2 -0.013644   0.125918  -0.108  0.91400
ts1.l3 -0.417360   1.638504  -0.255  0.79962
ts2.l3  0.454878   0.484598   0.939  0.35084
ts3.l3 -0.307640   0.579544  -0.531  0.59706
```

```
ts4.l3 -3.308247   2.467943  -1.340  0.18403
ts5.l3 -0.017321   0.009253  -1.872  0.06501 .
ts6.l3  0.152797   0.118513   1.289  0.20116
ts1.l4 -0.570530   1.547540  -0.369  0.71339
ts2.l4  0.072479   0.460925   0.157  0.87546
ts3.l4 -0.958335   0.538034  -1.781  0.07883 .
ts4.l4 -0.256628   2.140338  -0.120  0.90487
ts5.l4 -0.014349   0.007734  -1.855  0.06738 .
ts6.l4  0.002621   0.116140   0.023  0.98206
const  -2.252502   1.020400  -2.207  0.03026 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.028 on 77 degrees of freedom
Multiple R-Squared: 0.3499,     Adjusted R-squared: 0.1472
F-statistic: 1.727 on 24 and 77 DF,  p-value: 0.03804



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4      ts5      ts6
ts1  0.13876  0.07500  0.08695  0.02488   -4.979   0.3196
ts2  0.07500  1.01657 -0.17241 -0.02577    6.309  -1.0695
ts3  0.08695 -0.17241  1.34297 -0.22554   -5.641  -0.2223
ts4  0.02488 -0.02577 -0.22554  0.27483   -4.124  -0.2283
ts5 -4.97938  6.30900 -5.64061 -4.12393 4685.543 -24.1934
ts6  0.31957 -1.06954 -0.22231 -0.22830  -24.193  16.2261

Correlation matrix of residuals:
        ts1      ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.19970  0.20142  0.12742 -0.19528  0.21297
ts2  0.1997  1.00000 -0.14756 -0.04876  0.09141 -0.26334
ts3  0.2014 -0.14756  1.00000 -0.37124 -0.07111 -0.04762
ts4  0.1274 -0.04876 -0.37124  1.00000 -0.11492 -0.10811
ts5 -0.1953  0.09141 -0.07111 -0.11492  1.00000 -0.08774
ts6  0.2130 -0.26334 -0.04762 -0.10811 -0.08774  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)log_likelihood <- logLik(var_model)num_parameters <- length(coef(var_model
))
Error: unexpected symbol in "BIC <- BIC(var_model)log_likelihood"
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
>
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("AIC:", AIC, "\n")
AIC: 2640.037
> cat("BIC:", BIC, "\n")
BIC: 3033.783
> cat("HQC:", HQC, "\n")
HQC: 2362.307
> plot(stability(var_model))
> var_model <- VAR(train_set, p=2)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 104
Log Likelihood: -1252.276
Roots of the characteristic polynomial:
0.8271 0.722 0.722 0.6885 0.6885 0.6141 0.6141 0.5519 0.5519 0.4364 0.1571 0.1571
Call:
VAR(y = train_set, p = 2)
```

```
Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.5109403  0.1196802   4.269 4.81e-05 ***
ts2.l1 -0.0608881  0.0386110  -1.577   0.1183
ts3.l1  0.0801893  0.0389629   2.058   0.0424 *
ts4.l1  0.0549885  0.1917670   0.287   0.7750
ts5.l1  0.0008186  0.0005436   1.506   0.1356
ts6.l1 -0.0084201  0.0096910  -0.869   0.3872
ts1.l2 -0.0280974  0.1231998  -0.228   0.8201
ts2.l2 -0.0627634  0.0352148  -1.782   0.0780 .
ts3.l2 -0.0392048  0.0444841  -0.881   0.3805
ts4.l2 -0.2425311  0.1682944  -1.441   0.1530
ts5.l2  0.0005318  0.0005881   0.904   0.3682
ts6.l2 -0.0108716  0.0096258  -1.129   0.2617
const   0.0804778  0.0640603   1.256   0.2122
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3682 on 91 degrees of freedom
Multiple R-Squared: 0.3815,     Adjusted R-squared: 0.2999
F-statistic: 4.677 on 12 and 91 DF,  p-value: 6.957e-06


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.162817   0.356882   0.456   0.6493
ts2.l1 -0.069194   0.115137  -0.601   0.5494
ts3.l1  0.480720   0.116186   4.138 7.82e-05 ***
ts4.l1  0.643854   0.571843   1.126   0.2632
ts5.l1 -0.002209   0.001621  -1.363   0.1764
ts6.l1 -0.054734   0.028898  -1.894   0.0614 .
ts1.l2 -0.678929   0.367377  -1.848   0.0678 .
ts2.l2 -0.156407   0.105009  -1.489   0.1398
ts3.l2 -0.061970   0.132650  -0.467   0.6415
ts4.l2 -0.742538   0.501848  -1.480   0.1424
ts5.l2 -0.002866   0.001754  -1.634   0.1057
ts6.l2 -0.001921   0.028704  -0.067   0.9468
const   1.142811   0.191026   5.983 4.27e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.098 on 91 degrees of freedom
Multiple R-Squared: 0.338,      Adjusted R-squared: 0.2507
F-statistic: 3.873 on 12 and 91 DF,  p-value: 8.673e-05


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.635412   0.387479   1.640 0.104486
ts2.l1  0.108243   0.125008   0.866 0.388829
ts3.l1  0.466353   0.126147   3.697 0.000373 ***
ts4.l1 -0.016150   0.620868  -0.026 0.979305
ts5.l1 -0.003175   0.001760  -1.804 0.074525 .
ts6.l1 -0.022326   0.031376  -0.712 0.478542
ts1.l2  0.245733   0.398874   0.616 0.539389
ts2.l2 -0.116831   0.114012  -1.025 0.308211
```

```
ts3.l2  0.161525   0.144023   1.122 0.265015
ts4.l2  0.893332   0.544873   1.640 0.104557
ts5.l2 -0.001392   0.001904  -0.731 0.466540
ts6.l2  0.021388   0.031165   0.686 0.494280
const   0.107322   0.207403   0.517 0.606091
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.192 on 91 degrees of freedom
Multiple R-Squared: 0.4359,     Adjusted R-squared: 0.3615
F-statistic:  5.86 on 12 and 91 DF,  p-value: 1.974e-07


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.4413287  0.1735718  -2.543 0.012691 *
ts2.l1 -0.0658387  0.0559975  -1.176 0.242764
ts3.l1 -0.2162729  0.0565078  -3.827 0.000237 ***
ts4.l1  0.3896131  0.2781191   1.401 0.164649
ts5.l1  0.0025951  0.0007884   3.291 0.001420 **
ts6.l1 -0.0050794  0.0140548  -0.361 0.718636
ts1.l2  0.2068214  0.1786763   1.158 0.250089
ts2.l2  0.0656297  0.0510720   1.285 0.202038
ts3.l2  0.1119968  0.0645152   1.736 0.085953 .
ts4.l2  0.2782495  0.2440768   1.140 0.257275
ts5.l2  0.0023369  0.0008529   2.740 0.007398 **
ts6.l2 -0.0014864  0.0139603  -0.106 0.915439
const   0.0623817  0.0929064   0.671 0.503637
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.534 on 91 degrees of freedom
Multiple R-Squared: 0.5161,     Adjusted R-squared: 0.4522
F-statistic: 8.086 on 12 and 91 DF,  p-value: 4.124e-10


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

       Estimate Std. Error t value Pr(>|t|)
ts1.l1  32.7141    22.3948   1.461   0.1475
ts2.l1   4.6170     7.2250   0.639   0.5244
ts3.l1  -1.5461     7.2908  -0.212   0.8325
ts4.l1 -38.4677    35.8839  -1.072   0.2866
ts5.l1  -0.7168     0.1017  -7.047 3.43e-10 ***
ts6.l1  -1.2129     1.8134  -0.669   0.5053
ts1.l2 -43.6693    23.0534  -1.894   0.0614 .
ts2.l2  13.7932     6.5895   2.093   0.0391 *
ts3.l2  -5.2913     8.3240  -0.636   0.5266
ts4.l2   8.9991    31.4916   0.286   0.7757
ts5.l2  -0.4481     0.1100  -4.072 9.93e-05 ***
ts6.l2   1.4847     1.8012   0.824   0.4119
const  -16.0056    11.9871  -1.335   0.1851
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 68.9 on 91 degrees of freedom
Multiple R-Squared: 0.4277,     Adjusted R-squared: 0.3522
F-statistic: 5.666 on 12 and 91 DF,  p-value: 3.488e-07
```

```
Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.538616   1.304592   0.413   0.6807
ts2.l1  0.259848   0.420885   0.617   0.5385
ts3.l1 -0.157208   0.424721  -0.370   0.7121
ts4.l1  3.788641   2.090385   1.812   0.0732 .
ts5.l1 -0.008785   0.005926  -1.482   0.1417
ts6.l1  0.329939   0.105638   3.123   0.0024 **
ts1.l2 -0.883599   1.342958  -0.658   0.5122
ts2.l2  0.998203   0.383865   2.600   0.0109 *
ts3.l2  0.578495   0.484906   1.193   0.2360
ts4.l2 -3.516961   1.834518  -1.917   0.0584 .
ts5.l2 -0.002348   0.006411  -0.366   0.7150
ts6.l2 -0.022794   0.104928  -0.217   0.8285
const  -1.763918   0.698299  -2.526   0.0133 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.014 on 91 degrees of freedom
Multiple R-Squared: 0.2448,     Adjusted R-squared: 0.1452
F-statistic: 2.458 on 12 and 91 DF,  p-value: 0.007972



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4      ts5     ts6
ts1  0.13557  0.10268  0.08213  0.02869   -5.058  0.2359
ts2  0.10268  1.20550 -0.21583  0.01775   -1.080 -1.0859
ts3  0.08213 -0.21583  1.42106 -0.25239   -8.951 -0.1723
ts4  0.02869  0.01775 -0.25239  0.28515   -4.141 -0.2625
ts5 -5.05829 -1.08027 -8.95067 -4.14145 4746.909  7.8483
ts6  0.23592 -1.08585 -0.17229 -0.26252    7.848 16.1089

Correlation matrix of residuals:
        ts1      ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.25399  0.18713  0.14590 -0.19940  0.15964
ts2  0.2540  1.00000 -0.16490  0.03028 -0.01428 -0.24641
ts3  0.1871 -0.16490  1.00000 -0.39649 -0.10898 -0.03601
ts4  0.1459  0.03028 -0.39649  1.00000 -0.11257 -0.12249
ts5 -0.1994 -0.01428 -0.10898 -0.11257  1.00000  0.02838
ts6  0.1596 -0.24641 -0.03601 -0.12249  0.02838  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("AIC:", AIC, "\n")
AIC: 2660.552
> cat("BIC:", BIC, "\n")
BIC: 2866.815
> cat("HQC:", HQC, "\n")
HQC: 2526.822
> cat("RMSE:", RMSE, "\n")
RMSE: 0.7471908 2.856689 1.446747 1.328938 108.0238 5.661724
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.218561 3.226323 2.612527 2.221969 115.7346 9.460426
> cat("MAE:", MAE, "\n")
MAE: 1.075512 2.474723 1.908565 1.494408 86.37605 6.855286
```

```
> plot(stability(var_model))
> var_model <- VAR(train_set, p=3)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 103
Log Likelihood: -1214.572
Roots of the characteristic polynomial:
0.8392 0.8392   0.8 0.7267 0.7267 0.7248 0.7248 0.6774 0.6774 0.6124 0.5922 0.4858 0.4858 0.4432
0.4432 0.2755 0.2573 0.2573
Call:
VAR(y = train_set, p = 3)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.4549455  0.1234002   3.687 0.000402 ***
ts2.l1 -0.0431743  0.0402585  -1.072 0.286599
ts3.l1  0.0921593  0.0414750   2.222 0.028969 *
ts4.l1  0.1256885  0.2090803   0.601 0.549359
ts5.l1  0.0010047  0.0005844   1.719 0.089250 .
ts6.l1  0.0007158  0.0106713   0.067 0.946683
ts1.l2 -0.1064368  0.1412808  -0.753 0.453334
ts2.l2 -0.0585144  0.0394590  -1.483 0.141839
ts3.l2 -0.0262984  0.0476558  -0.552 0.582523
ts4.l2 -0.3621294  0.2041859  -1.774 0.079766 .
ts5.l2  0.0008457  0.0007141   1.184 0.239678
ts6.l2 -0.0057821  0.0104343  -0.554 0.580956
ts1.l3  0.0987710  0.1283778   0.769 0.443827
ts2.l3 -0.0695740  0.0386313  -1.801 0.075296 .
ts3.l3 -0.0315957  0.0480135  -0.658 0.512300
ts4.l3  0.0140845  0.1886988   0.075 0.940678
ts5.l3  0.0004956  0.0006619   0.749 0.456134
ts6.l3 -0.0159360  0.0098268  -1.622 0.108620
const   0.1213626  0.0770483   1.575 0.118981
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3653 on 84 degrees of freedom
Multiple R-Squared: 0.4047,     Adjusted R-squared: 0.2772
F-statistic: 3.173 on 18 and 84 DF,  p-value: 0.0001805


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.194819   0.373292   0.522 0.603118
ts2.l1 -0.016817   0.121784  -0.138 0.890499
ts3.l1  0.480425   0.125464   3.829 0.000247 ***
ts4.l1  0.607044   0.632479   0.960 0.339917
ts5.l1 -0.001548   0.001768  -0.876 0.383700
ts6.l1 -0.057365   0.032281  -1.777 0.079183 .
ts1.l2 -1.126237   0.427382  -2.635 0.010012 *
ts2.l2 -0.123767   0.119366  -1.037 0.302771
ts3.l2 -0.107790   0.144161  -0.748 0.456727
ts4.l2 -0.413334   0.617673  -0.669 0.505215
ts5.l2 -0.002562   0.002160  -1.186 0.238948
ts6.l2  0.020927   0.031564   0.663 0.509156
ts1.l3  0.757063   0.388350   1.949 0.054580 .
```

```
ts2.l3 -0.023893   0.116862  -0.204 0.838495
ts3.l3  0.046108   0.145243   0.317 0.751687
ts4.l3  0.101173   0.570823   0.177 0.859746
ts5.l3  0.001141   0.002002   0.570 0.570199
ts6.l3 -0.038147   0.029727  -1.283 0.202928
const   1.073932   0.233075   4.608 1.44e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.105 on 84 degrees of freedom
Multiple R-Squared: 0.3807,     Adjusted R-squared: 0.2479
F-statistic: 2.868 on 18 and 84 DF,  p-value: 0.0006053


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.577711   0.386960   1.493  0.13920
ts2.l1  0.093424   0.126243   0.740  0.46134
ts3.l1  0.387815   0.130058   2.982  0.00375 **
ts4.l1 -0.158861   0.655637  -0.242  0.80914
ts5.l1 -0.002664   0.001832  -1.454  0.14977
ts6.l1  0.005706   0.033463   0.171  0.86501
ts1.l2 -0.027696   0.443030  -0.063  0.95030
ts2.l2 -0.158470   0.123736  -1.281  0.20382
ts3.l2  0.198724   0.149440   1.330  0.18719
ts4.l2  0.729629   0.640289   1.140  0.25772
ts5.l2 -0.001839   0.002239  -0.821  0.41388
ts6.l2  0.009074   0.032720   0.277  0.78220
ts1.l3  0.761998   0.402569   1.893  0.06182 .
ts2.l3 -0.313724   0.121140  -2.590  0.01132 *
ts3.l3  0.089961   0.150561   0.598  0.55178
ts4.l3  0.919907   0.591724   1.555  0.12380
ts5.l3 -0.001367   0.002076  -0.658  0.51207
ts6.l3 -0.014674   0.030815  -0.476  0.63516
const   0.507450   0.241609   2.100  0.03870 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.145 on 84 degrees of freedom
Multiple R-Squared: 0.5188,     Adjusted R-squared: 0.4156
F-statistic: 5.031 on 18 and 84 DF,  p-value: 1.544e-07


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.4843539  0.1833409  -2.642 0.009833 **
ts2.l1 -0.0545079  0.0598137  -0.911 0.364748
ts3.l1 -0.1939360  0.0616212  -3.147 0.002281 **
ts4.l1  0.4365386  0.3106394   1.405 0.163623
ts5.l1  0.0030079  0.0008682   3.464 0.000839 ***
ts6.l1 -0.0033920  0.0158548  -0.214 0.831110
ts1.l2  0.2219207  0.2099069   1.057 0.293436
ts2.l2  0.0874366  0.0586259   1.491 0.139594
ts3.l2  0.1405658  0.0708043   1.985 0.050377 .
ts4.l2  0.3576114  0.3033676   1.179 0.241804
ts5.l2  0.0033402  0.0010610   3.148 0.002275 **
ts6.l2  0.0022714  0.0155027   0.147 0.883865
ts1.l3 -0.0466213  0.1907364  -0.244 0.807496
ts2.l3 -0.0301661  0.0573961  -0.526 0.600567
ts3.l3 -0.0569996  0.0713357  -0.799 0.426525
```

```
ts4.l3 -0.2928155  0.2803578  -1.044 0.299281
ts5.l3  0.0016311  0.0009835   1.659 0.100938
ts6.l3  0.0013619  0.0146002   0.093 0.925901
const   0.0571082  0.1144739   0.499 0.619171
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5427 on 84 degrees of freedom
Multiple R-Squared: 0.5381,     Adjusted R-squared: 0.4391
F-statistic: 5.436 on 18 and 84 DF,  p-value: 3.653e-08


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

       Estimate Std. Error t value Pr(>|t|)
ts1.l1  35.8678    22.8177   1.572   0.1197
ts2.l1   1.1287     7.4441   0.152   0.8798
ts3.l1  -2.0429     7.6691  -0.266   0.7906
ts4.l1 -36.5638    38.6607  -0.946   0.3470
ts5.l1  -0.8288     0.1081  -7.670 2.76e-11 ***
ts6.l1  -1.4683     1.9732  -0.744   0.4589
ts1.l2 -14.6104    26.1240  -0.559   0.5775
ts2.l2  12.3492     7.2963   1.693   0.0943 .
ts3.l2  -5.5043     8.8120  -0.625   0.5339
ts4.l2 -21.8757    37.7556  -0.579   0.5639
ts5.l2  -0.5949     0.1320  -4.505 2.13e-05 ***
ts6.l2  -0.2010     1.9294  -0.104   0.9173
ts1.l3 -52.6180    23.7381  -2.217   0.0294 *
ts2.l3  11.7977     7.1432   1.652   0.1024
ts3.l3  -2.0408     8.8781  -0.230   0.8188
ts4.l3   8.4254    34.8919   0.241   0.8098
ts5.l3  -0.2566     0.1224  -2.096   0.0391 *
ts6.l3   3.3246     1.8171   1.830   0.0709 .
const  -22.0362    14.2469  -1.547   0.1257
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 67.54 on 84 degrees of freedom
Multiple R-Squared: 0.4922,     Adjusted R-squared: 0.3834
F-statistic: 4.524 on 18 and 84 DF,  p-value: 9.876e-07


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.536324   1.372424   0.391  0.69694
ts2.l1  0.178136   0.447744   0.398  0.69175
ts3.l1 -0.139811   0.461274  -0.303  0.76256
ts4.l1  3.978406   2.325335   1.711  0.09079 .
ts5.l1 -0.011755   0.006499  -1.809  0.07408 .
ts6.l1  0.339792   0.118683   2.863  0.00530 **
ts1.l2 -0.184351   1.571287  -0.117  0.90688
ts2.l2  1.167328   0.438853   2.660  0.00936 **
ts3.l2  0.741483   0.530015   1.399  0.16550
ts4.l2 -4.020334   2.270900  -1.770  0.08029 .
ts5.l2 -0.006396   0.007942  -0.805  0.42289
ts6.l2 -0.082598   0.116048  -0.712  0.47858
ts1.l3 -0.895204   1.427784  -0.627  0.53237
ts2.l3  0.220073   0.429647   0.512  0.60984
ts3.l3 -0.402536   0.533993  -0.754  0.45306
ts4.l3 -0.518608   2.098657  -0.247  0.80542
ts5.l3 -0.006708   0.007362  -0.911  0.36483
```

```
ts6.l3  0.182244   0.109292   1.667  0.09914 .
const  -1.959342   0.856910  -2.287  0.02474 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.063 on 84 degrees of freedom
Multiple R-Squared: 0.2789,     Adjusted R-squared: 0.1244
F-statistic: 1.805 on 18 and 84 DF,  p-value: 0.03775



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4      ts5      ts6
ts1  0.13343  0.09719  0.06935  0.03000   -4.192  0.31250
ts2  0.09719  1.22098 -0.26367  0.02554    4.172 -0.98236
ts3  0.06935 -0.26367  1.31203 -0.25088   -5.505 -0.08785
ts4  0.03000  0.02554 -0.25088  0.29453   -3.663 -0.28646
ts5 -4.19240  4.17164 -5.50489 -3.66327 4561.988 -9.89003
ts6  0.31250 -0.98236 -0.08785 -0.28646   -9.890 16.50391

Correlation matrix of residuals:
        ts1     ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.2408  0.16575  0.15135 -0.16993  0.21059
ts2  0.2408  1.0000 -0.20832  0.04260  0.05590 -0.21884
ts3  0.1658 -0.2083  1.00000 -0.40359 -0.07115 -0.01888
ts4  0.1514  0.0426 -0.40359  1.00000 -0.09994 -0.12993
ts5 -0.1699  0.0559 -0.07115 -0.09994  1.00000 -0.03604
ts6  0.2106 -0.2188 -0.01888 -0.12993 -0.03604  1.00000


> AIC <- AIC(var_model)
> > BIC <- BIC(var_model)
Error: unexpected '>' in ">"
> > log_likelihood <- logLik(var_model)
Error: unexpected '>' in ">"
> > num_parameters <- length(coef(var_model))
Error: unexpected '>' in ">"
> > HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
Error: unexpected '>' in ">"
> > cat("AIC:", AIC, "\n")BIC <- BIC(var_model)
Error: unexpected '>' in ">"
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> cat("AIC:", AIC, "\n")
AIC: 2657.144
> BIC <- BIC(var_model)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.218561 3.226323 2.612527 2.221969 115.7346 9.460426
> cat("BIC:", BIC, "\n")
BIC: 2957.503
> cat("HQC:", HQC, "\n")
HQC: 2451.413
> cat("MAE:", MAE, "\n")
MAE: 1.075512 2.474723 1.908565 1.494408 86.37605 6.855286
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.291972 3.484975 4.335526 2.264448 105.2608 9.354743
> cat("MAE:", MAE, "\n")
MAE: 1.132891 2.464543 3.474136 1.427417 89.69872 6.875458
> plot(stability(var_model))
```

```
> var_model <- VAR(train_set, p=5)
> summary(var_model)

VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 101
Log Likelihood: -1141.051
Roots of the characteristic polynomial:
0.9732 0.9732 0.9224 0.9224 0.8895 0.8895 0.8344 0.8344 0.8271 0.8271 0.8218 0.8218 0.8119 0.8119
 0.8058 0.7857 0.7857 0.7845 0.7845 0.7719 0.7719 0.7499 0.6004 0.6004 0.5451 0.5451 0.527 0.527
0.1885 0.1885
Call:
VAR(y = train_set, p = 5)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.4453813  0.1361192   3.272  0.00166 **
ts2.l1 -0.0380034  0.0491104  -0.774  0.44163
ts3.l1  0.0682744  0.0457614   1.492  0.14020
ts4.l1  0.0157340  0.2415402   0.065  0.94825
ts5.l1  0.0014147  0.0006729   2.102  0.03911 *
ts6.l1  0.0052705  0.0119904   0.440  0.66161
ts1.l2 -0.1332913  0.1567414  -0.850  0.39801
ts2.l2 -0.0368791  0.0442508  -0.833  0.40745
ts3.l2  0.0029547  0.0537855   0.055  0.95635
ts4.l2 -0.3339464  0.2444370  -1.366  0.17625
ts5.l2  0.0011973  0.0008879   1.348  0.18186
ts6.l2 -0.0039795  0.0121436  -0.328  0.74411
ts1.l3  0.0513737  0.1587735   0.324  0.74723
ts2.l3 -0.0789673  0.0468977  -1.684  0.09667 .
ts3.l3 -0.0234467  0.0581788  -0.403  0.68817
ts4.l3  0.1067969  0.2467255   0.433  0.66645
ts5.l3  0.0010162  0.0010083   1.008  0.31705
ts6.l3 -0.0170164  0.0117983  -1.442  0.15368
ts1.l4  0.3100195  0.1619140   1.915  0.05962 .
ts2.l4 -0.0491538  0.0481931  -1.020  0.31127
ts3.l4 -0.0480214  0.0546269  -0.879  0.38237
ts4.l4 -0.0158223  0.2468636  -0.064  0.94908
ts5.l4  0.0007834  0.0009455   0.829  0.41017
ts6.l4 -0.0109975  0.0116037  -0.948  0.34651
ts1.l5 -0.2314414  0.1614064  -1.434  0.15605
ts2.l5  0.0123697  0.0457775   0.270  0.78779
ts3.l5 -0.0031569  0.0533868  -0.059  0.95302
ts4.l5 -0.2457563  0.2054571  -1.196  0.23568
ts5.l5  0.0006726  0.0007566   0.889  0.37703
ts6.l5 -0.0051031  0.0112010  -0.456  0.65009
const   0.1512376  0.1137010   1.330  0.18779
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3713 on 70 degrees of freedom
Multiple R-Squared: 0.4832,     Adjusted R-squared: 0.2617
F-statistic: 2.181 on 30 and 70 DF,  p-value: 0.003898


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const
```

```
         Estimate Std. Error t value Pr(>|t|)
ts1.l1  5.316e-01  3.847e-01   1.382 0.171467
ts2.l1 -1.094e-01  1.388e-01  -0.788 0.433414
ts3.l1  3.660e-01  1.293e-01   2.830 0.006076 **
ts4.l1  5.609e-01  6.827e-01   0.822 0.414123
ts5.l1  2.642e-07  1.902e-03   0.000 0.999890
ts6.l1 -6.923e-02  3.389e-02  -2.043 0.044855 *
ts1.l2 -1.230e+00  4.430e-01  -2.775 0.007065 **
ts2.l2 -6.810e-02  1.251e-01  -0.544 0.587851
ts3.l2 -4.596e-03  1.520e-01  -0.030 0.975970
ts4.l2  1.147e-02  6.909e-01   0.017 0.986803
ts5.l2 -1.627e-03  2.510e-03  -0.648 0.519018
ts6.l2  1.957e-02  3.432e-02   0.570 0.570496
ts1.l3  2.529e-01  4.488e-01   0.564 0.574884
ts2.l3  1.107e-01  1.326e-01   0.835 0.406427
ts3.l3  1.368e-01  1.644e-01   0.832 0.408422
ts4.l3  1.019e+00  6.974e-01   1.461 0.148555
ts5.l3  6.335e-04  2.850e-03   0.222 0.824753
ts6.l3 -2.734e-02  3.335e-02  -0.820 0.415133
ts1.l4  1.536e+00  4.577e-01   3.356 0.001280 **
ts2.l4 -1.869e-01  1.362e-01  -1.372 0.174497
ts3.l4 -1.513e-01  1.544e-01  -0.980 0.330375
ts4.l4 -6.027e-01  6.978e-01  -0.864 0.390632
ts5.l4 -7.637e-05  2.672e-03  -0.029 0.977284
ts6.l4  1.674e-03  3.280e-02   0.051 0.959439
ts1.l5 -2.683e-01  4.562e-01  -0.588 0.558431
ts2.l5  9.903e-02  1.294e-01   0.765 0.446611
ts3.l5  9.691e-02  1.509e-01   0.642 0.522849
ts4.l5 -8.534e-03  5.807e-01  -0.015 0.988317
ts5.l5  3.435e-05  2.139e-03   0.016 0.987230
ts6.l5  1.362e-02  3.166e-02   0.430 0.668476
const   1.104e+00  3.214e-01   3.435 0.000999 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.049 on 70 degrees of freedom
Multiple R-Squared: 0.5342,     Adjusted R-squared: 0.3346
F-statistic: 2.676 on 30 and 70 DF,  p-value: 0.0003752


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.544368   0.429343   1.268  0.20903
ts2.l1  0.217964   0.154902   1.407  0.16382
ts3.l1  0.455728   0.144339   3.157  0.00235 **
ts4.l1  0.082845   0.761858   0.109  0.91372
ts5.l1 -0.004007   0.002122  -1.888  0.06319 .
ts6.l1  0.008893   0.037820   0.235  0.81479
ts1.l2 -0.063108   0.494388  -0.128  0.89879
ts2.l2 -0.160314   0.139574  -1.149  0.25463
ts3.l2  0.155537   0.169649   0.917  0.36239
ts4.l2  1.050579   0.770995   1.363  0.17737
ts5.l2 -0.003635   0.002801  -1.298  0.19862
ts6.l2  0.019265   0.038303   0.503  0.61656
ts1.l3  1.326602   0.500798   2.649  0.00997 **
ts2.l3 -0.395076   0.147923  -2.671  0.00940 **
ts3.l3  0.104963   0.183505   0.572  0.56916
ts4.l3  0.655727   0.778213   0.843  0.40232
ts5.l3 -0.002631   0.003180  -0.827  0.41084
ts6.l3 -0.030172   0.037214  -0.811  0.42024
ts1.l4 -0.690518   0.510703  -1.352  0.18070
ts2.l4  0.024195   0.152009   0.159  0.87399
ts3.l4 -0.018711   0.172302  -0.109  0.91384
ts4.l4 -0.539951   0.778649  -0.693  0.49032
```

```
ts5.l4 -0.002496   0.002982  -0.837  0.40541
ts6.l4  0.012291   0.036600   0.336  0.73801
ts1.l5 -0.498984   0.509102  -0.980  0.33040
ts2.l5 -0.136967   0.144390  -0.949  0.34609
ts3.l5  0.060796   0.168391   0.361  0.71916
ts4.l5 -0.247074   0.648046  -0.381  0.70416
ts5.l5 -0.001619   0.002386  -0.678  0.49985
ts6.l5 -0.032062   0.035330  -0.908  0.36725
const   0.538390   0.358632   1.501  0.13779
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.171 on 70 degrees of freedom
Multiple R-Squared: 0.5767,     Adjusted R-squared: 0.3952
F-statistic: 3.178 on 30 and 70 DF,  p-value: 3.603e-05


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.5683068  0.1887627  -3.011 0.003623 **
ts2.l1 -0.0808045  0.0681036  -1.186 0.239439
ts3.l1 -0.2305508  0.0634594  -3.633 0.000530 ***
ts4.l1  0.4233215  0.3349549   1.264 0.210488
ts5.l1  0.0036420  0.0009331   3.903 0.000216 ***
ts6.l1  0.0027864  0.0166277   0.168 0.867399
ts1.l2  0.1538198  0.2173605   0.708 0.481499
ts2.l2  0.1077958  0.0613646   1.757 0.083352 .
ts3.l2  0.2160283  0.0745869   2.896 0.005034 **
ts4.l2  0.3630048  0.3389720   1.071 0.287893
ts5.l2  0.0047424  0.0012313   3.851 0.000257 ***
ts6.l2  0.0038560  0.0168400   0.229 0.819554
ts1.l3 -0.3905309  0.2201785  -1.774 0.080462 .
ts2.l3 -0.0096661  0.0650352  -0.149 0.882274
ts3.l3 -0.0082082  0.0806791  -0.102 0.919255
ts4.l3 -0.0184566  0.3421455  -0.054 0.957134
ts5.l3  0.0032093  0.0013983   2.295 0.024729 *
ts6.l3  0.0206879  0.0163612   1.264 0.210262
ts1.l4  0.4944273  0.2245335   2.202 0.030961 *
ts2.l4 -0.1098459  0.0668316  -1.644 0.104739
ts3.l4  0.0083304  0.0757536   0.110 0.912750
ts4.l4 -0.3039160  0.3423371  -0.888 0.377706
ts5.l4  0.0027907  0.0013112   2.128 0.036825 *
ts6.l4 -0.0293694  0.0160914  -1.825 0.072242 .
ts1.l5 -0.0443027  0.2238296  -0.198 0.843673
ts2.l5  0.0050439  0.0634817   0.079 0.936898
ts3.l5 -0.1581064  0.0740339  -2.136 0.036213 *
ts4.l5 -0.3537797  0.2849168  -1.242 0.218494
ts5.l5  0.0019676  0.0010492   1.875 0.064913 .
ts6.l5 -0.0015406  0.0155330  -0.099 0.921275
const   0.1471301  0.1576744   0.933 0.353963
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5149 on 70 degrees of freedom
Multiple R-Squared: 0.652,      Adjusted R-squared: 0.5029
F-statistic: 4.372 on 30 and 70 DF,  p-value: 1.917e-07


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const
```

```
       Estimate Std. Error t value Pr(>|t|)
ts1.l1  20.3971    25.4853   0.800  0.42622
ts2.l1   5.3050     9.1948   0.577  0.56582
ts3.l1  -2.4480     8.5678  -0.286  0.77594
ts4.l1 -61.0758    45.2230  -1.351  0.18119
ts5.l1  -0.8298     0.1260  -6.587 7.01e-09 ***
ts6.l1  -0.1976     2.2449  -0.088  0.93011
ts1.l2 -22.1735    29.3463  -0.756  0.45244
ts2.l2  12.5068     8.2850   1.510  0.13565
ts3.l2  -9.4899    10.0701  -0.942  0.34924
ts4.l2 -49.0788    45.7654  -1.072  0.28722
ts5.l2  -0.5501     0.1662  -3.309  0.00148 **
ts6.l2   1.4180     2.2736   0.624  0.53486
ts1.l3 -43.9311    29.7268  -1.478  0.14394
ts2.l3  12.3120     8.7805   1.402  0.16528
ts3.l3  -6.2053    10.8927  -0.570  0.57072
ts4.l3 -54.0150    46.1938  -1.169  0.24624
ts5.l3  -0.1430     0.1888  -0.757  0.45135
ts6.l3   2.7821     2.2090   1.259  0.21205
ts1.l4  -4.9492    30.3148  -0.163  0.87078
ts2.l4 -10.1227     9.0231  -1.122  0.26575
ts3.l4 -15.4202    10.2277  -1.508  0.13613
ts4.l4  45.7672    46.2197   0.990  0.32548
ts5.l4   0.1176     0.1770   0.664  0.50860
ts6.l4  -1.2108     2.1725  -0.557  0.57909
ts1.l5  14.8657    30.2198   0.492  0.62431
ts2.l5   1.1024     8.5708   0.129  0.89803
ts3.l5  12.9867     9.9955   1.299  0.19812
ts4.l5  63.4106    38.4673   1.648  0.10375
ts5.l5   0.1521     0.1417   1.074  0.28653
ts6.l5  -0.3776     2.0971  -0.180  0.85763
const  -14.7144    21.2880  -0.691  0.49172
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 69.52 on 70 degrees of freedom
Multiple R-Squared: 0.5516,     Adjusted R-squared: 0.3595
F-statistic: 2.871 on 30 and 70 DF,  p-value: 0.0001503


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.136342   1.511756   0.090   0.9284
ts2.l1  0.080767   0.545426   0.148   0.8827
ts3.l1 -0.161139   0.508231  -0.317   0.7521
ts4.l1  4.205649   2.682574   1.568   0.1214
ts5.l1 -0.016278   0.007473  -2.178   0.0328 *
ts6.l1  0.288624   0.133167   2.167   0.0336 *
ts1.l2  0.134179   1.740789   0.077   0.9388
ts2.l2  1.198790   0.491454   2.439   0.0173 *
ts3.l2  0.911445   0.597349   1.526   0.1316
ts4.l2 -2.545942   2.714746  -0.938   0.3516
ts5.l2 -0.015830   0.009862  -1.605   0.1130
ts6.l2 -0.029888   0.134868  -0.222   0.8253
ts1.l3 -1.137283   1.763358  -0.645   0.5211
ts2.l3  0.410124   0.520851   0.787   0.4337
ts3.l3 -0.097730   0.646140  -0.151   0.8802
ts4.l3 -2.379067   2.740162  -0.868   0.3882
ts5.l3 -0.017958   0.011199  -1.604   0.1133
ts6.l3  0.179671   0.131033   1.371   0.1747
ts1.l4  0.186618   1.798235   0.104   0.9176
ts2.l4  0.136653   0.535238   0.255   0.7992
ts3.l4 -0.621140   0.606692  -1.024   0.3094
```

```
ts4.l4 -0.435747   2.741697  -0.159   0.8742
ts5.l4 -0.014278   0.010501  -1.360   0.1783
ts6.l4  0.001352   0.128872   0.010   0.9917
ts1.l5 -0.068182   1.792598  -0.038   0.9698
ts2.l5 -0.482803   0.508410  -0.950   0.3456
ts3.l5 -0.605014   0.592920  -1.020   0.3111
ts4.l5 -2.311830   2.281831  -1.013   0.3145
ts5.l5 -0.001145   0.008403  -0.136   0.8920
ts6.l5 -0.050608   0.124400  -0.407   0.6854
const  -1.525881   1.262777  -1.208   0.2310
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.124 on 70 degrees of freedom
Multiple R-Squared: 0.367,      Adjusted R-squared: 0.09566
F-statistic: 1.353 on 30 and 70 DF,  p-value: 0.1508



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4      ts5      ts6
ts1  0.13787  0.07484  0.07923  0.01923   -5.184   0.2947
ts2  0.07484  1.10145 -0.19022 -0.02574    6.683  -1.1368
ts3  0.07923 -0.19022  1.37160 -0.21884   -5.404  -0.3770
ts4  0.01923 -0.02574 -0.21884  0.26513   -3.823  -0.2912
ts5 -5.18450  6.68272 -5.40391 -3.82271 4832.815 -17.4674
ts6  0.29473 -1.13678 -0.37705 -0.29123  -17.467  17.0053

Correlation matrix of residuals:
        ts1      ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.19206  0.18220  0.10060 -0.20085  0.19249
ts2  0.1921  1.00000 -0.15476 -0.04763  0.09159 -0.26266
ts3  0.1822 -0.15476  1.00000 -0.36290 -0.06637 -0.07807
ts4  0.1006 -0.04763 -0.36290  1.00000 -0.10679 -0.13716
ts5 -0.2009  0.09159 -0.06637 -0.10679  1.00000 -0.06093
ts6  0.1925 -0.26266 -0.07807 -0.13716 -0.06093  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
>
> num_parameters <- length(coef(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> forecasts <- predict(var_model, n.ahead=12)
>
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.775888 6.981608 11.98211 3.997824 295.6232 16.81454
> cat("MAE:", MAE, "\n")
MAE: 1.624689 5.30327 10.40162 3.508354 251.81 13.81874
> cat("AIC:", AIC, "\n")
AIC: 2654.103
> cat("BIC:", BIC, "\n")
BIC: 3140.515
> cat("HQC:", HQC, "\n")
HQC: 2304.372
> plot(stability(var_model))
> var_model <- VAR(train_set, p=7)
> summary(var_model)

VAR Estimation Results:
========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 99
```

```
Log Likelihood: -1062.158
Roots of the characteristic polynomial:
1.075 1.075 0.9802 0.9802 0.9381 0.9381 0.931 0.931 0.9252 0.9252 0.891 0.891 0.889 0.889 0.8854
0.8854 0.8661 0.8661 0.8505 0.8505 0.8484 0.8484 0.8405 0.8405 0.8403 0.8403 0.8203 0.8203 0.8116
 0.8116 0.8096 0.8096 0.783 0.783 0.7584 0.7584 0.7119 0.7107 0.7107 0.5811 0.5811 0.547
Call:
VAR(y = train_set, p = 7)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.3848253  0.1476293   2.607   0.0117 *
ts2.l1 -0.0348605  0.0530620  -0.657   0.5139
ts3.l1  0.0949452  0.0522415   1.817   0.0745 .
ts4.l1  0.0680395  0.2705909   0.251   0.8024
ts5.l1  0.0012233  0.0007171   1.706   0.0936 .
ts6.l1  0.0074730  0.0135192   0.553   0.5826
ts1.l2 -0.1864568  0.1691006  -1.103   0.2749
ts2.l2 -0.0350430  0.0529415  -0.662   0.5107
ts3.l2 -0.0168493  0.0589044  -0.286   0.7759
ts4.l2 -0.4170275  0.2725528  -1.530   0.1316
ts5.l2  0.0014438  0.0009924   1.455   0.1513
ts6.l2  0.0011537  0.0134362   0.086   0.9319
ts1.l3  0.0316481  0.1753939   0.180   0.8575
ts2.l3 -0.0605202  0.0576893  -1.049   0.2987
ts3.l3 -0.0299487  0.0657402  -0.456   0.6505
ts4.l3  0.0345111  0.2954466   0.117   0.9074
ts5.l3  0.0013964  0.0011202   1.247   0.2178
ts6.l3 -0.0180730  0.0134210  -1.347   0.1835
ts1.l4  0.2046413  0.1896824   1.079   0.2853
ts2.l4 -0.0486607  0.0555011  -0.877   0.3844
ts3.l4 -0.0540416  0.0665291  -0.812   0.4201
ts4.l4 -0.0910159  0.2947235  -0.309   0.7586
ts5.l4  0.0018230  0.0011756   1.551   0.1266
ts6.l4 -0.0035980  0.0139187  -0.259   0.7970
ts1.l5 -0.1504124  0.2045407  -0.735   0.4652
ts2.l5 -0.0128393  0.0556621  -0.231   0.8184
ts3.l5  0.0172867  0.0663153   0.261   0.7953
ts4.l5 -0.1371478  0.2876660  -0.477   0.6354
ts5.l5  0.0018894  0.0011749   1.608   0.1134
ts6.l5 -0.0101641  0.0137818  -0.737   0.4639
ts1.l6  0.0411011  0.1992817   0.206   0.8373
ts2.l6 -0.0637801  0.0542128  -1.176   0.2444
ts3.l6 -0.0299428  0.0652752  -0.459   0.6482
ts4.l6 -0.2026193  0.2839365  -0.714   0.4784
ts5.l6  0.0013337  0.0011028   1.209   0.2316
ts6.l6 -0.0021965  0.0127005  -0.173   0.8633
ts1.l7 -0.0712866  0.1838378  -0.388   0.6997
ts2.l7 -0.0048269  0.0507397  -0.095   0.9246
ts3.l7 -0.0205575  0.0614021  -0.335   0.7390
ts4.l7 -0.0121909  0.2277988  -0.054   0.9575
ts5.l7 -0.0004106  0.0008782  -0.468   0.6419
ts6.l7 -0.0215926  0.0121508  -1.777   0.0810 .
const   0.2221141  0.1491325   1.489   0.1420
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3826 on 56 degrees of freedom
Multiple R-Squared:  0.56,      Adjusted R-squared: 0.2301
F-statistic: 1.697 on 42 and 56 DF,  p-value: 0.0322
```

```
Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.2476765  0.4023550   0.616  0.54067
ts2.l1 -0.0921348  0.1446174  -0.637  0.52666
ts3.l1  0.4028071  0.1423811   2.829  0.00647 **
ts4.l1  0.9175761  0.7374797   1.244  0.21861
ts5.l1 -0.0002914  0.0019545  -0.149  0.88203
ts6.l1 -0.0628527  0.0368457  -1.706  0.09358 .
ts1.l2 -1.1573504  0.4608737  -2.511  0.01494 *
ts2.l2 -0.0462905  0.1442889  -0.321  0.74954
ts3.l2 -0.0036558  0.1605405  -0.023  0.98191
ts4.l2  0.0462628  0.7428268   0.062  0.95056
ts5.l2 -0.0008501  0.0027048  -0.314  0.75446
ts6.l2  0.0111362  0.0366195   0.304  0.76217
ts1.l3  0.1309454  0.4780259   0.274  0.78515
ts2.l3  0.0058777  0.1572287   0.037  0.97031
ts3.l3  0.1528053  0.1791710   0.853  0.39738
ts4.l3  0.7641783  0.8052225   0.949  0.34668
ts5.l3  0.0013004  0.0030531   0.426  0.67179
ts6.l3 -0.0259838  0.0365782  -0.710  0.48043
ts1.l4  1.7570321  0.5169684   3.399  0.00125 **
ts2.l4 -0.2352392  0.1512650  -1.555  0.12555
ts3.l4 -0.1324370  0.1813212  -0.730  0.46819
ts4.l4 -0.7680382  0.8032518  -0.956  0.34310
ts5.l4  0.0011243  0.0032041   0.351  0.72697
ts6.l4 -0.0340352  0.0379345  -0.897  0.37345
ts1.l5 -0.5102096  0.5574636  -0.915  0.36399
ts2.l5  0.0400303  0.1517039   0.264  0.79285
ts3.l5  0.0867905  0.1807383   0.480  0.63296
ts4.l5  0.4631194  0.7840168   0.591  0.55710
ts5.l5  0.0011554  0.0032021   0.361  0.71959
ts6.l5  0.0347688  0.0375616   0.926  0.35860
ts1.l6  0.0393331  0.5431307   0.072  0.94253
ts2.l6  0.1736695  0.1477538   1.175  0.24481
ts3.l6  0.1423562  0.1779036   0.800  0.42698
ts4.l6 -0.3686846  0.7738524  -0.476  0.63562
ts5.l6  0.0023504  0.0030057   0.782  0.43752
ts6.l6 -0.0220268  0.0346145  -0.636  0.52714
ts1.l7  0.1811811  0.5010392   0.362  0.71900
ts2.l7 -0.2004607  0.1382880  -1.450  0.15275
ts3.l7 -0.3275716  0.1673477  -1.957  0.05529 .
ts4.l7 -0.8741975  0.6208524  -1.408  0.16464
ts5.l7  0.0009072  0.0023934   0.379  0.70610
ts6.l7 -0.0350228  0.0331162  -1.058  0.29479
const   1.3306523  0.4064519   3.274  0.00182 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.043 on 56 degrees of freedom
Multiple R-Squared: 0.6318,     Adjusted R-squared: 0.3556
F-statistic: 2.288 on 42 and 56 DF,  p-value: 0.001975


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

         Estimate Std. Error t value Pr(>|t|)
```

```
ts1.l1  0.6856479  0.4536382   1.511  0.13630
ts2.l1  0.2411581  0.1630500   1.479  0.14473
ts3.l1  0.4860782  0.1605287   3.028  0.00372 **
ts4.l1 -0.0366387  0.8314771  -0.044  0.96501
ts5.l1 -0.0046096  0.0022036  -2.092  0.04100 *
ts6.l1  0.0158982  0.0415420   0.383  0.70339
ts1.l2 -0.1147025  0.5196156  -0.221  0.82609
ts2.l2 -0.2766573  0.1626797  -1.701  0.09456 .
ts3.l2  0.1677991  0.1810026   0.927  0.35788
ts4.l2  0.6147822  0.8375058   0.734  0.46597
ts5.l2 -0.0032579  0.0030495  -1.068  0.28996
ts6.l2  0.0292931  0.0412870   0.710  0.48096
ts1.l3  1.4724184  0.5389539   2.732  0.00841 **
ts2.l3 -0.4972126  0.1772688  -2.805  0.00691 **
ts3.l3 -0.0249381  0.2020078  -0.123  0.90219
ts4.l3  0.7329376  0.9078543   0.807  0.42289
ts5.l3 -0.0008968  0.0034422  -0.261  0.79541
ts6.l3 -0.0659077  0.0412404  -1.598  0.11564
ts1.l4 -0.9954749  0.5828600  -1.708  0.09319 .
ts2.l4  0.0897936  0.1705449   0.527  0.60061
ts3.l4 -0.0249459  0.2044320  -0.122  0.90332
ts4.l4 -0.7560613  0.9056324  -0.835  0.40735
ts5.l4  0.0002684  0.0036124   0.074  0.94104
ts6.l4  0.0326726  0.0427696   0.764  0.44812
ts1.l5 -0.9935098  0.6285167  -1.581  0.11957
ts2.l5  0.0311471  0.1710397   0.182  0.85616
ts3.l5  0.1829046  0.2037748   0.898  0.37325
ts4.l5  0.5033933  0.8839457   0.569  0.57130
ts5.l5  0.0010429  0.0036102   0.289  0.77375
ts6.l5 -0.0339157  0.0423491  -0.801  0.42660
ts1.l6  0.9955462  0.6123569   1.626  0.10962
ts2.l6 -0.1098427  0.1665862  -0.659  0.51236
ts3.l6  0.0060837  0.2005788   0.030  0.97591
ts4.l6  0.2124151  0.8724858   0.243  0.80854
ts5.l6  0.0032134  0.0033887   0.948  0.34707
ts6.l6  0.0452190  0.0390264   1.159  0.25150
ts1.l7  0.2392391  0.5649005   0.424  0.67355
ts2.l7  0.1207636  0.1559139   0.775  0.44186
ts3.l7 -0.0831872  0.1886775  -0.441  0.66099
ts4.l7  0.1501994  0.6999848   0.215  0.83088
ts5.l7 -0.0006483  0.0026985  -0.240  0.81102
ts6.l7  0.0148425  0.0373371   0.398  0.69249
const   0.5551316  0.4582573   1.211  0.23083
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.176 on 56 degrees of freedom
Multiple R-Squared: 0.6578,     Adjusted R-squared: 0.4012
F-statistic: 2.563 on 42 and 56 DF,  p-value: 0.0005351


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.5419428  0.1944572  -2.787 0.007251 **
ts2.l1 -0.1099678  0.0698932  -1.573 0.121267
ts3.l1 -0.2877533  0.0688124  -4.182 0.000103 ***
ts4.l1  0.1773038  0.3564221   0.497 0.620816
ts5.l1  0.0035126  0.0009446   3.719 0.000465 ***
ts6.l1 -0.0027489  0.0178074  -0.154 0.877873
ts1.l2  0.1187303  0.2227391   0.533 0.596110
ts2.l2  0.1914040  0.0697345   2.745 0.008123 **
ts3.l2  0.2604782  0.0775888   3.357 0.001421 **
```

```
ts4.l2  0.5929259  0.3590063   1.652 0.104219
ts5.l2  0.0037470  0.0013072   2.866 0.005840 **
ts6.l2  0.0095586  0.0176981   0.540 0.591277
ts1.l3 -0.3889656  0.2310287  -1.684 0.097821 .
ts2.l3 -0.0095401  0.0759883  -0.126 0.900540
ts3.l3  0.0252544  0.0865929   0.292 0.771636
ts4.l3 -0.3519142  0.3891620  -0.904 0.369717
ts5.l3  0.0023956  0.0014756   1.624 0.110093
ts6.l3  0.0329661  0.0176781   1.865 0.067453 .
ts1.l4  0.7178236  0.2498495   2.873 0.005734 **
ts2.l4 -0.1759576  0.0731060  -2.407 0.019412 *
ts3.l4 -0.1031408  0.0876321  -1.177 0.244184
ts4.l4 -0.3884578  0.3882096  -1.001 0.321305
ts5.l4  0.0020705  0.0015485   1.337 0.186602
ts6.l4 -0.0403421  0.0183337  -2.200 0.031917 *
ts1.l5  0.1359609  0.2694208   0.505 0.615791
ts2.l5 -0.0354119  0.0733181  -0.483 0.630985
ts3.l5 -0.2415022  0.0873504  -2.765 0.007699 **
ts4.l5 -0.8138442  0.3789133  -2.148 0.036068 *
ts5.l5  0.0015706  0.0015475   1.015 0.314506
ts6.l5 -0.0174079  0.0181534  -0.959 0.341714
ts1.l6 -0.6035860  0.2624937  -2.299 0.025232 *
ts2.l6  0.0688295  0.0714090   0.964 0.339252
ts3.l6  0.0047173  0.0859804   0.055 0.956442
ts4.l6  0.9090348  0.3740009   2.431 0.018304 *
ts5.l6 -0.0011877  0.0014526  -0.818 0.417039
ts6.l6  0.0012890  0.0167291   0.077 0.938857
ts1.l7  0.4129837  0.2421510   1.705 0.093647 .
ts2.l7  0.0219237  0.0668343   0.328 0.744112
ts3.l7  0.2082080  0.0808787   2.574 0.012715 *
ts4.l7  0.4013407  0.3000564   1.338 0.186450
ts5.l7 -0.0003837  0.0011567  -0.332 0.741323
ts6.l7  0.0099132  0.0160050   0.619 0.538174
const   0.1064759  0.1964372   0.542 0.589944
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.504 on 56 degrees of freedom
Multiple R-Squared: 0.7332,     Adjusted R-squared: 0.533
F-statistic: 3.663 on 42 and 56 DF,  p-value: 3.841e-06


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

        Estimate Std. Error t value Pr(>|t|)
ts1.l1   9.87952   27.52114   0.359   0.7210
ts2.l1   9.06943    9.89185   0.917   0.3631
ts3.l1   2.58995    9.73889   0.266   0.7913
ts4.l1 -27.97215   50.44371  -0.555   0.5814
ts5.l1  -0.76833    0.13369  -5.747 3.91e-07 ***
ts6.l1   1.36429    2.52025   0.541   0.5904
ts1.l2  -8.68218   31.52382  -0.275   0.7840
ts2.l2   7.32642    9.86938   0.742   0.4610
ts3.l2 -11.36367   10.98099  -1.035   0.3052
ts4.l2 -65.17827   50.80945  -1.283   0.2048
ts5.l2  -0.46337    0.18501  -2.505   0.0152 *
ts6.l2   0.53185    2.50478   0.212   0.8326
ts1.l3 -49.13533   32.69703  -1.503   0.1385
ts2.l3  13.04727   10.75447   1.213   0.2301
ts3.l3  -5.84349   12.25532  -0.477   0.6354
ts4.l3 -32.78424   55.07733  -0.595   0.5541
ts5.l3  -0.19081    0.20883  -0.914   0.3648
ts6.l3   2.44589    2.50195   0.978   0.3325
```

```
ts1.l4 -14.09548   35.36071  -0.399   0.6917
ts2.l4 -10.58840   10.34655  -1.023   0.3105
ts3.l4 -15.26826   12.40239  -1.231   0.2234
ts4.l4  28.07429   54.94253   0.511   0.6114
ts5.l4   0.12934    0.21916   0.590   0.5575
ts6.l4  -1.31476    2.59473  -0.507   0.6144
ts1.l5  -5.68241   38.13059  -0.149   0.8821
ts2.l5   9.04701   10.37657   0.872   0.3870
ts3.l5  16.71817   12.36253   1.352   0.1817
ts4.l5  83.58404   53.62685   1.559   0.1247
ts5.l5   0.16177    0.21902   0.739   0.4632
ts6.l5   1.80007    2.56922   0.701   0.4864
ts1.l6  12.70427   37.15021   0.342   0.7337
ts2.l6   1.62882   10.10638   0.161   0.8725
ts3.l6   4.13566   12.16863   0.340   0.7352
ts4.l6 -71.32762   52.93161  -1.348   0.1832
ts5.l6   0.09941    0.20559   0.484   0.6306
ts6.l6   1.56258    2.36764   0.660   0.5120
ts1.l7   0.86277   34.27115   0.025   0.9800
ts2.l7 -13.25748    9.45892  -1.402   0.1666
ts3.l7 -15.14504   11.44661  -1.323   0.1912
ts4.l7  14.66747   42.46639   0.345   0.7311
ts5.l7   0.24521    0.16371   1.498   0.1398
ts6.l7  -3.31951    2.26515  -1.465   0.1484
const   -9.81898   27.80136  -0.353   0.7253
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 71.33 on 56 degrees of freedom
Multiple R-Squared: 0.6223,     Adjusted R-squared: 0.3391
F-statistic: 2.197 on 42 and 56 DF,  p-value: 0.003044


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + ts1.l2 + ts2.l2 + ts3.l2 + ts4.l2 + t
s5.l2 + ts6.l2 + ts1.l3 + ts2.l3 + ts3.l3 + ts4.l3 + ts5.l3 + ts6.l3 + ts1.l4 + ts2.l4 + ts3.l4 +
 ts4.l4 + ts5.l4 + ts6.l4 + ts1.l5 + ts2.l5 + ts3.l5 + ts4.l5 + ts5.l5 + ts6.l5 + ts1.l6 + ts2.l6
 + ts3.l6 + ts4.l6 + ts5.l6 + ts6.l6 + ts1.l7 + ts2.l7 + ts3.l7 + ts4.l7 + ts5.l7 + ts6.l7 + cons
t

        Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.829961   1.644587  -0.505   0.6158
ts2.l1  0.252116   0.591110   0.427   0.6714
ts3.l1 -0.080245   0.581969  -0.138   0.8908
ts4.l1  4.146146   3.014377   1.375   0.1745
ts5.l1 -0.014487   0.007989  -1.813   0.0751 .
ts6.l1  0.373363   0.150603   2.479   0.0162 *
ts1.l2  0.919737   1.883777   0.488   0.6273
ts2.l2  1.133363   0.589767   1.922   0.0597 .
ts3.l2  0.782728   0.656194   1.193   0.2380
ts4.l2 -4.189147   3.036233  -1.380   0.1732
ts5.l2 -0.008217   0.011056  -0.743   0.4604
ts6.l2  0.012787   0.149679   0.085   0.9322
ts1.l3 -1.112409   1.953885  -0.569   0.5714
ts2.l3  0.480150   0.642657   0.747   0.4581
ts3.l3 -0.099066   0.732344  -0.135   0.8929
ts4.l3 -0.775915   3.291270  -0.236   0.8145
ts5.l3 -0.016810   0.012479  -1.347   0.1834
ts6.l3  0.118844   0.149510   0.795   0.4300
ts1.l4 -0.096891   2.113059  -0.046   0.9636
ts2.l4 -0.241477   0.618281  -0.391   0.6976
ts3.l4 -1.000040   0.741133  -1.349   0.1827
ts4.l4  0.039856   3.283214   0.012   0.9904
ts5.l4 -0.006279   0.013096  -0.479   0.6335
ts6.l4 -0.023358   0.155054  -0.151   0.8808
ts1.l5  0.371867   2.278579   0.163   0.8709
ts2.l5 -0.254466   0.620075  -0.410   0.6831
ts3.l5 -0.184856   0.738751  -0.250   0.8033
```

```
ts4.l5  0.051350   3.204593   0.016   0.9873
ts5.l5  0.005924   0.013088   0.453   0.6526
ts6.l5 -0.011148   0.153529  -0.073   0.9424
ts1.l6 -1.819496   2.219994  -0.820   0.4159
ts2.l6 -0.045361   0.603929  -0.075   0.9404
ts3.l6  0.685269   0.727164   0.942   0.3500
ts4.l6 -4.592078   3.163047  -1.452   0.1521
ts5.l6  0.006934   0.012285   0.564   0.5747
ts6.l6  0.140915   0.141483   0.996   0.3235
ts1.l7  1.053940   2.047950   0.515   0.6088
ts2.l7 -0.608825   0.565239  -1.077   0.2860
ts3.l7 -0.526377   0.684018  -0.770   0.4448
ts4.l7  1.738842   2.537675   0.685   0.4960
ts5.l7  0.002046   0.009783   0.209   0.8351
ts6.l7 -0.163626   0.135359  -1.209   0.2318
const  -0.938108   1.661333  -0.565   0.5746
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.262 on 56 degrees of freedom
Multiple R-Squared: 0.4529,     Adjusted R-squared: 0.04249
F-statistic: 1.104 on 42 and 56 DF,  p-value: 0.3616



Covariance matrix of residuals:
         ts1      ts2      ts3      ts4       ts5      ts6
ts1  0.14640  0.06260  0.08365  0.03256   -6.0721   0.2561
ts2  0.06260  1.08743 -0.14284 -0.01365    5.4561  -1.5730
ts3  0.08365 -0.14284  1.38230 -0.20386   -6.6302  -0.6541
ts4  0.03256 -0.01365 -0.20386  0.25400   -0.3859  -0.1916
ts5 -6.07206  5.45608 -6.63024 -0.38593 5087.6201 -52.9670
ts6  0.25614 -1.57303 -0.65415 -0.19157  -52.9670  18.1675

Correlation matrix of residuals:
        ts1      ts2      ts3      ts4      ts5      ts6
ts1  1.0000  0.15690  0.18594  0.16885 -0.22249  0.15706
ts2  0.1569  1.00000 -0.11650 -0.02597  0.07335 -0.35391
ts3  0.1859 -0.11650  1.00000 -0.34404 -0.07906 -0.13053
ts4  0.1688 -0.02597 -0.34404  1.00000 -0.01074 -0.08918
ts5 -0.2225  0.07335 -0.07906 -0.01074  1.00000 -0.17422
ts6  0.1571 -0.35391 -0.13053 -0.08918 -0.17422  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
>
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.571786 8.003734 9.532438 4.896223 280.9148 20.49107
> cat("MAE:", MAE, "\n")
MAE: 1.299165 6.451585 7.913661 4.26102 250.31 16.44372
> cat("AIC:", AIC, "\n")
AIC: 2640.316
> cat("BIC:", BIC, "\n")
BIC: 3309.857
> cat("HQC:", HQC, "\n")
HQC: 2146.586
> plot(stability(var_model))
> var_model <- VAR(train_set, p=1)
> summary(var_model)
```

```
VAR Estimation Results:
=========================
Endogenous variables: ts1, ts2, ts3, ts4, ts5, ts6
Deterministic variables: const
Sample size: 105
Log Likelihood: -1306.379
Roots of the characteristic polynomial:
0.6814 0.5379 0.3565 0.342 0.342 0.1817
Call:
VAR(y = train_set, p = 1)


Estimation results for equation ts1:
====================================
ts1 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.5263648  0.0983910   5.350 5.78e-07 ***
ts2.l1 -0.0693572  0.0328392  -2.112   0.0372 *
ts3.l1  0.0620016  0.0354376   1.750   0.0833 .
ts4.l1  0.0418705  0.1573654   0.266   0.7907
ts5.l1  0.0006097  0.0004745   1.285   0.2018
ts6.l1 -0.0124116  0.0089251  -1.391   0.1675
const   0.0248458  0.0518312   0.479   0.6328
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.3647 on 98 degrees of freedom
Multiple R-Squared: 0.3564,     Adjusted R-squared: 0.317
F-statistic: 9.044 on 6 and 98 DF,  p-value: 7.307e-08


Estimation results for equation ts2:
====================================
ts2 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.107102   0.306294  -0.350   0.7273
ts2.l1 -0.016967   0.102229  -0.166   0.8685
ts3.l1  0.493503   0.110318   4.473 2.08e-05 ***
ts4.l1  0.953042   0.489883   1.945   0.0546 .
ts5.l1 -0.001637   0.001477  -1.108   0.2705
ts6.l1 -0.043771   0.027784  -1.575   0.1184
const   0.917863   0.161352   5.689 1.33e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.135 on 98 degrees of freedom
Multiple R-Squared: 0.2381,     Adjusted R-squared: 0.1915
F-statistic: 5.104 on 6 and 98 DF,  p-value: 0.0001341


Estimation results for equation ts3:
====================================
ts3 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1  0.735265   0.320775   2.292   0.0240 *
ts2.l1  0.164595   0.107063   1.537   0.1274
ts3.l1  0.491289   0.115534   4.252 4.84e-05 ***
ts4.l1  0.145679   0.513044   0.284   0.7770
ts5.l1 -0.002867   0.001547  -1.854   0.0668 .
ts6.l1 -0.011623   0.029098  -0.399   0.6904
const  -0.059581   0.168981  -0.353   0.7252
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 1.189 on 98 degrees of freedom
Multiple R-Squared: 0.3981,     Adjusted R-squared: 0.3613
F-statistic:  10.8 on 6 and 98 DF,  p-value: 3.365e-09


Estimation results for equation ts4:
====================================
ts4 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

         Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.3753888  0.1517320  -2.474 0.015079 *
ts2.l1 -0.0620682  0.0506424  -1.226 0.223279
ts3.l1 -0.2170941  0.0546495  -3.972 0.000136 ***
ts4.l1  0.0837932  0.2426783   0.345 0.730620
ts5.l1  0.0018562  0.0007317   2.537 0.012762 *
ts6.l1 -0.0101462  0.0137638  -0.737 0.462782
const   0.1541826  0.0799306   1.929 0.056629 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.5624 on 98 degrees of freedom
Multiple R-Squared: 0.424,      Adjusted R-squared: 0.3888
F-statistic: 12.03 on 6 and 98 DF,  p-value: 4.397e-10


Estimation results for equation ts5:
====================================
ts5 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

       Estimate Std. Error t value Pr(>|t|)
ts1.l1  7.11422   19.98664   0.356    0.723
ts2.l1  8.60523    6.67078   1.290    0.200
ts3.l1  5.29414    7.19862   0.735    0.464
ts4.l1 10.48015   31.96641   0.328    0.744
ts5.l1 -0.57131    0.09638  -5.928 4.59e-08 ***
ts6.l1  0.41529    1.81301   0.229    0.819
const  -9.33297   10.52873  -0.886    0.378
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 74.08 on 98 degrees of freedom
Multiple R-Squared: 0.2876,     Adjusted R-squared: 0.2439
F-statistic: 6.593 on 6 and 98 DF,  p-value: 7.087e-06


Estimation results for equation ts6:
====================================
ts6 = ts1.l1 + ts2.l1 + ts3.l1 + ts4.l1 + ts5.l1 + ts6.l1 + const

        Estimate Std. Error t value Pr(>|t|)
ts1.l1 -0.079754   1.149213  -0.069  0.94481
ts2.l1  0.339864   0.383563   0.886  0.37775
ts3.l1  0.118802   0.413914   0.287  0.77470
ts4.l1  0.862654   1.838037   0.469  0.63987
ts5.l1 -0.006020   0.005542  -1.086  0.28004
ts6.l1  0.322732   0.104246   3.096  0.00256 **
const  -0.656965   0.605392  -1.085  0.28050
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 4.26 on 98 degrees of freedom
Multiple R-Squared: 0.09725,    Adjusted R-squared: 0.04198
F-statistic: 1.759 on 6 and 98 DF,  p-value: 0.1154



Covariance matrix of residuals:
```

```
         ts1      ts2      ts3      ts4      ts5     ts6
ts1  0.13300  0.11380  0.07229  0.02151   -5.791  0.1943
ts2  0.11380  1.28887 -0.18128 -0.06151    4.790 -1.0820
ts3  0.07229 -0.18128  1.41363 -0.24608   -8.815 -0.5194
ts4  0.02151 -0.06151 -0.24608  0.31629   -9.006 -0.1244
ts5 -5.79093  4.79009 -8.81463 -9.00603 5487.983 13.6857
ts6  0.19434 -1.08201 -0.51944 -0.12439   13.686 18.1440

Correlation matrix of residuals:
        ts1      ts2     ts3      ts4      ts5      ts6
ts1  1.0000  0.27486  0.1667  0.10486 -0.21435  0.12511
ts2  0.2749  1.00000 -0.1343 -0.09634  0.05696 -0.22375
ts3  0.1667 -0.13430  1.0000 -0.36802 -0.10008 -0.10257
ts4  0.1049 -0.09634 -0.3680  1.00000 -0.21616 -0.05193
ts5 -0.2143  0.05696 -0.1001 -0.21616  1.00000  0.04337
ts6  0.1251 -0.22375 -0.1026 -0.05193  0.04337  1.00000


> AIC <- AIC(var_model)
> BIC <- BIC(var_model)
> log_likelihood <- logLik(var_model)
> num_parameters <- length(coef(var_model))
> HQC <- -2 * as.numeric(log_likelihood) + 2 * num_parameters * log(log(num_observations))
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 0.7700858 3.510706 2.092037 1.554113 117.4166 5.734688
> cat("MAE:", MAE, "\n")
MAE: 0.6087649 2.83258 1.533186 0.9359122 93.49757 4.648526
> cat("AIC:", AIC, "\n")
AIC: 2696.757
> cat("BIC:", BIC, "\n")
BIC: 2808.224
> cat("HQC:", HQC, "\n")
HQC: 2635.027
> var_model <- VAR(train_set, p=6)
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.627494 6.797625 10.82598 4.592681 355.325 20.5848
> cat("MAE:", MAE, "\n")
MAE: 1.419453 5.258024 9.007064 4.040439 309.1655 17.83669
> plot(stability(var_model))
> var_model <- VAR(train_set, p=1)
> plot(stability(var_model))
> var_model <- VAR(train_set, p=4)
> forecasts <- predict(var_model, n.ahead=12)
> forecasted_values <- sapply(forecasts$fcst, function(x) x[, "fcst"])
> actual_values <- as.matrix(test_set)
> RMSE <- sqrt(colMeans((actual_values - forecasted_values)^2))
> MAE <- colMeans(abs(actual_values - forecasted_values))
> cat("RMSE:", RMSE, "\n")
RMSE: 1.710565 5.458001 5.021193 2.495168 179.2677 11.66931
> cat("MAE:", MAE, "\n")
MAE: 1.472663 3.71091 4.567531 1.682052 132.45 8.403488
> save.image("C:\\Users\\minhas01\\Desktop\\Nahayan Minhas\\Workspace main")
>
```