**Introduction**

The two time series with monthly frequency provided are Capacity Utilisation Rate (TCU) and Consumer Price Index Inflation Rate (CPIAUCSL). TCU represents the extent to which the production capacity of firms is being used, while CPIAUCSL represents the changes in the cost of a basket of goods and services purchased by households. TCU is measured as the ratio of actual output to potential output. The actual output is measured using industrial production data, while potential output is estimated using data on capacity constraints, including production capacity and capital stock. The output gap is then calculated as the difference between actual output and potential output, and TCU is obtained by scaling the output gap by potential output. CPIAUCSL is measured as the percentage change in the Consumer Price Index (CPI) from one year ago. CPI is a measure of the average price level of a basket of goods and services consumed by households. The percentage change is obtained by calculating the difference between the current month’s CPI and the CPI of the same month one year ago, divided by the CPI of the same month one year ago, and then multiplied by 100.

**Loading Packages**

library(dynamac) # For ARDL estimation  
library(forecast) # For ARIMA model estimation

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

library(tseries) # for time series models and diagnostic checks  
library(nlme) # to estimate ARIMA models

##   
## Attaching package: 'nlme'

## The following object is masked from 'package:forecast':  
##   
## getResponse

library(pdfetch) # to fetch data directly from online data bases  
library(zoo) # for the zoo function for daily time series

##   
## Attaching package: 'zoo'

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

library(urca) # for unit root tests  
library(vars) # for Granger tests and VAR estimation

## Loading required package: MASS

## Loading required package: strucchange

## Loading required package: sandwich

## Loading required package: lmtest

library(car) # for regression diagnostics and hypothesis testing

## Loading required package: carData

library(dynlm) # for Vector Error Correction Model(VECM)  
library(tsDyn) # for linear and non-linear VAR and VECM models  
library(gets) # for Isat function: step and impsulse indicator saturation

## Loading required package: parallel

##   
## Attaching package: 'gets'

## The following object is masked from 'package:car':  
##   
## logit

library(readxl) # to read Excel files and load the data from Excel files  
library(aod) # for Wald tests  
library(egcm) # Engle-Granger cointegration test

## Loading required package: xts

library(aTSA) # Engle-Granger cointegration test

##   
## Attaching package: 'aTSA'

## The following object is masked from 'package:vars':  
##   
## arch.test

## The following objects are masked from 'package:tseries':  
##   
## adf.test, kpss.test, pp.test

## The following object is masked from 'package:forecast':  
##   
## forecast

## The following object is masked from 'package:graphics':  
##   
## identify

library(tidyverse)

## ── Attaching packages ─────────────────────────────────────── tidyverse 1.3.2  
## ──

## ✔ ggplot2 3.4.0 ✔ purrr 0.3.5   
## ✔ tibble 3.1.8 ✔ dplyr 1.0.10  
## ✔ tidyr 1.2.1 ✔ stringr 1.4.1   
## ✔ readr 2.1.3 ✔ forcats 0.5.2   
## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ stringr::boundary() masks strucchange::boundary()  
## ✖ dplyr::collapse() masks nlme::collapse()  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::first() masks xts::first()  
## ✖ dplyr::lag() masks stats::lag()  
## ✖ dplyr::last() masks xts::last()  
## ✖ dplyr::recode() masks car::recode()  
## ✖ dplyr::select() masks MASS::select()  
## ✖ purrr::some() masks car::some()

**Clear the data buffer:**

rm(list=ls())

**Inflation data**

The CPI data is read from FRED using the pdfetch\_FRED() function from the quantmod package. The names() function is used to assign the name “CPI” to the resulting data. The inflation rate is calculated by taking the first difference of the logarithm of the CPI series, lagged by 12 periods (i.e., one year). This gives the percentage change in the CPI from one year ago, which is a common measure of inflation. The resulting series is multiplied by 100 to convert it from a decimal to a percentage. The names() function is then used again to assign the name “Inflation” to the resulting data. The resulting inflation series is converted to a time series using the ts() function, with a start date of January 1947 and a frequency of 12 (monthly data). The na.omit() function is then used to remove any missing values from the series, which are present because the CPI data only begins in January 1948. The capacity utilization data is obtained using a similar process. The pdfetch\_FRED() function is used to download the data for “TCU” (total capacity utilization), which is then assigned the name “TCU” using names(). The resulting data is converted to a time series using the ts() function, with a start date of January 1967 and a frequency of 12 (monthly data).

CPI = pdfetch\_FRED("CPIAUCSL")  
names(CPI) = "CPI"  
  
Inflation = diff(log(CPI), lag = 12) \* 100 # Percent change from year ago  
names(Inflation) = "Inflation"  
  
Inflation = ts(Inflation, start=c(1947, 1), frequency=12)  
Inflation = na.omit(Inflation) # inflation series begins in January 1948

**Capacity utilization data:**

TCU = pdfetch\_FRED("TCU")  
names(TCU) = "TCU"  
TCU = ts(TCU, start=c(1967, 1), frequency=12)

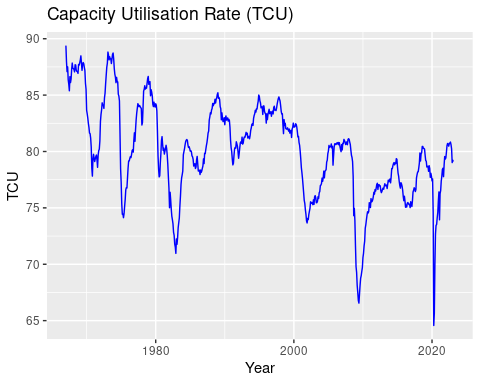
**How the Data is Measured**

The data consists of two time series: the Consumer Price Index (CPI) and the Capacity Utilization Rate (CUR). The CPI measures the average change in prices over time of a fixed basket of goods and services consumed by households. It is calculated by the Bureau of Labor Statistics (BLS) in the United States and is widely used as a measure of inflation. The CPI in this dataset is measured in levels and represents the monthly average price of the fixed basket of goods and services in the United States. The Capacity Utilization Rate (CUR) is a measure of the extent to which a firm is using its installed productive capacity. It is calculated as the ratio of actual output to potential output, where potential output is the maximum level of output that a firm can produce with its installed productive capacity. In this dataset, the CUR is measured in levels and represents the percentage of productive capacity that is being utilized in the manufacturing, mining, and electric and gas utilities industries in the United States.

**Plotting Data**

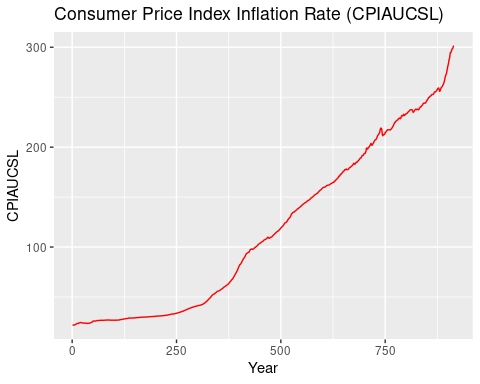
# Plot TCU in levels  
ggplot() +  
 geom\_line(data = TCU, aes(x = time(TCU), y = TCU), color = 'blue') +  
 labs(title = "Capacity Utilisation Rate (TCU)") +  
 ylab("TCU") +  
 xlab("Year")

## Don't know how to automatically pick scale for object of type <ts>. Defaulting  
## to continuous.  
## Don't know how to automatically pick scale for object of type <ts>. Defaulting  
## to continuous.



**Consumer Price Index Inflation Rate (CPIAUCSL)**

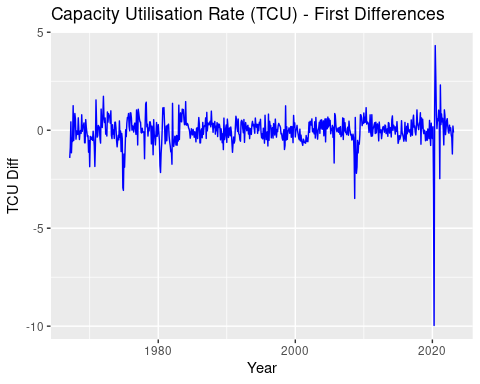
# Plot CPIAUCSL in levels  
ggplot() +  
 geom\_line(data = CPI, aes(x = time(CPI), y = CPI), color = 'red') +  
 labs(title = "Consumer Price Index Inflation Rate (CPIAUCSL)") +  
 ylab("CPIAUCSL") +  
 xlab("Year")



**Capacity Utilisation Rate (TCU) - First Differences**

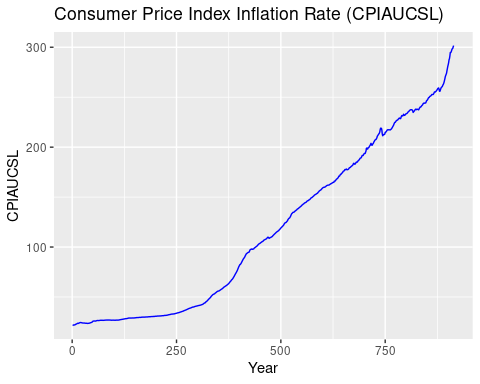
# Plot TCU in first differences  
ggplot() +  
 geom\_line(data = diff(TCU), aes(x = time(TCU)[2:length(time(TCU))], y = diff(TCU)), color = 'blue') +  
 labs(title = "Capacity Utilisation Rate (TCU) - First Differences") +  
 ylab("TCU Diff") +  
 xlab("Year")

## Don't know how to automatically pick scale for object of type <ts>. Defaulting  
## to continuous.



**Consumer Price Index Inflation Rate (CPIAUCSL)**

# Plot CPIAUCSL in first differences  
ggplot() +  
 geom\_line(data = CPI, aes(x = time(CPI), y = CPI), color = 'blue') +  
 labs(title = "Consumer Price Index Inflation Rate (CPIAUCSL)") +  
 ylab("CPIAUCSL") +  
 xlab("Year")



**ADF, PP, and KPSS unit root tests.**

To run the ADF, PP, and KPSS unit root tests, we can use the ur.df function from the urca package. The ADF and PP tests are used to test for a unit root in the series, while the KPSS test is used to test for stationarity. We need to run each test twice for each series, first in levels and then in first differences. ADF test for inflation in levels

ur.df(Inflation, type = "drift", lags = 12, selectlags = "AIC")

##   
## ###############################################################   
## # Augmented Dickey-Fuller Test Unit Root / Cointegration Test #   
## ###############################################################   
##   
## The value of the test statistic is: -2.7318 3.76

summary(ur.df(Inflation, type = "drift", lags = 12, selectlags = "AIC"))

##   
## ###############################################   
## # Augmented Dickey-Fuller Test Unit Root Test #   
## ###############################################   
##   
## Test regression drift   
##   
##   
## Call:  
## lm(formula = z.diff ~ z.lag.1 + 1 + z.diff.lag)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.85908 -0.16886 -0.00177 0.16451 1.56178   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.042765 0.018120 2.360 0.018492 \*   
## z.lag.1 -0.011893 0.004354 -2.732 0.006427 \*\*   
## z.diff.lag1 0.345556 0.029059 11.892 < 2e-16 \*\*\*  
## z.diff.lag2 0.059477 0.030952 1.922 0.054981 .   
## z.diff.lag3 -0.011299 0.030884 -0.366 0.714571   
## z.diff.lag4 0.036098 0.030778 1.173 0.241175   
## z.diff.lag5 0.064922 0.030300 2.143 0.032415 \*   
## z.diff.lag6 0.016143 0.030336 0.532 0.594761   
## z.diff.lag7 0.087664 0.030261 2.897 0.003862 \*\*   
## z.diff.lag8 0.020324 0.030367 0.669 0.503491   
## z.diff.lag9 0.037002 0.030347 1.219 0.223061   
## z.diff.lag10 0.084945 0.029876 2.843 0.004570 \*\*   
## z.diff.lag11 0.100161 0.029170 3.434 0.000623 \*\*\*  
## z.diff.lag12 -0.458721 0.027523 -16.667 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3147 on 875 degrees of freedom  
## Multiple R-squared: 0.4017, Adjusted R-squared: 0.3928   
## F-statistic: 45.19 on 13 and 875 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic is: -2.7318 3.76   
##   
## Critical values for test statistics:   
## 1pct 5pct 10pct  
## tau2 -3.43 -2.86 -2.57  
## phi1 6.43 4.59 3.78

**PP test for inflation in levels**

ur.pp(Inflation, type = "Z-alpha", lags = NULL)

##   
## ##################################################   
## # Phillips-Perron Unit Root / Cointegration Test #   
## ##################################################   
##   
## The value of the test statistic is: -25.7047

summary(ur.pp(Inflation, type = "Z-alpha", lags = NULL))

##   
## ##################################   
## # Phillips-Perron Unit Root Test #   
## ##################################   
##   
## Test regression with intercept   
##   
##   
## Call:  
## lm(formula = y ~ y.l1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.56152 -0.20952 0.00219 0.21075 2.07185   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.045593 0.022774 2.002 0.0456 \*   
## y.l1 0.985449 0.005161 190.957 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.4294 on 899 degrees of freedom  
## Multiple R-squared: 0.9759, Adjusted R-squared: 0.9759   
## F-statistic: 3.646e+04 on 1 and 899 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic, type: Z-alpha is: -25.7047   
##   
## aux. Z statistics  
## Z-tau-mu 2.7937

**KPSS test for inflation in levels**

summary(ur.kpss(Inflation, type = "tau", lags = "short"))

##   
## #######################   
## # KPSS Unit Root Test #   
## #######################   
##   
## Test is of type: tau with 6 lags.   
##   
## Value of test-statistic is: 1.0014   
##   
## Critical value for a significance level of:   
## 10pct 5pct 2.5pct 1pct  
## critical values 0.119 0.146 0.176 0.216

**ADF test for inflation in first differences**

ur.df(diff(Inflation), type = "drift", lags = 12, selectlags = "AIC")

##   
## ###############################################################   
## # Augmented Dickey-Fuller Test Unit Root / Cointegration Test #   
## ###############################################################   
##   
## The value of the test statistic is: -10.276 52.8135

summary(ur.df(diff(Inflation), type = "drift", lags = 12, selectlags = "AIC"))

##   
## ###############################################   
## # Augmented Dickey-Fuller Test Unit Root Test #   
## ###############################################   
##   
## Test regression drift   
##   
##   
## Call:  
## lm(formula = z.diff ~ z.lag.1 + 1 + z.diff.lag)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.83560 -0.16808 0.00028 0.17436 1.52771   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.002452 0.010504 0.233 0.8155   
## z.lag.1 -0.592255 0.057635 -10.276 < 2e-16 \*\*\*  
## z.diff.lag1 0.010934 0.053849 0.203 0.8391   
## z.diff.lag2 0.054194 0.053344 1.016 0.3099   
## z.diff.lag3 0.026421 0.052689 0.501 0.6162   
## z.diff.lag4 0.052259 0.051443 1.016 0.3100   
## z.diff.lag5 0.110522 0.049844 2.217 0.0269 \*   
## z.diff.lag6 0.113134 0.048202 2.347 0.0191 \*   
## z.diff.lag7 0.189033 0.045980 4.111 4.31e-05 \*\*\*  
## z.diff.lag8 0.194227 0.043760 4.439 1.02e-05 \*\*\*  
## z.diff.lag9 0.222688 0.040603 5.485 5.43e-08 \*\*\*  
## z.diff.lag10 0.296768 0.037375 7.940 6.18e-15 \*\*\*  
## z.diff.lag11 0.383413 0.034029 11.267 < 2e-16 \*\*\*  
## z.diff.lag12 -0.133037 0.031270 -4.254 2.32e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.313 on 874 degrees of freedom  
## Multiple R-squared: 0.5009, Adjusted R-squared: 0.4935   
## F-statistic: 67.47 on 13 and 874 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic is: -10.276 52.8135   
##   
## Critical values for test statistics:   
## 1pct 5pct 10pct  
## tau2 -3.43 -2.86 -2.57  
## phi1 6.43 4.59 3.78

**PP test for inflation in first differences**

ur.pp(diff(Inflation), type = "Z-alpha", lags = NULL)

##   
## ##################################################   
## # Phillips-Perron Unit Root / Cointegration Test #   
## ##################################################   
##   
## The value of the test statistic is: -549.2674

summary(ur.pp(diff(Inflation), type = "Z-alpha", lags = NULL))

##   
## ##################################   
## # Phillips-Perron Unit Root Test #   
## ##################################   
##   
## Test regression with intercept   
##   
##   
## Call:  
## lm(formula = y ~ y.l1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.18273 -0.19191 0.00128 0.20020 2.34577   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.001997 0.013148 -0.152 0.879   
## y.l1 0.402435 0.030510 13.190 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3944 on 898 degrees of freedom  
## Multiple R-squared: 0.1623, Adjusted R-squared: 0.1614   
## F-statistic: 174 on 1 and 898 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic, type: Z-alpha is: -549.2674   
##   
## aux. Z statistics  
## Z-tau-mu -0.1531

**KPSS test for inflation in first differences**

summary(ur.kpss(diff(Inflation), type = "tau", lags = "short"))

##   
## #######################   
## # KPSS Unit Root Test #   
## #######################   
##   
## Test is of type: tau with 6 lags.   
##   
## Value of test-statistic is: 0.0452   
##   
## Critical value for a significance level of:   
## 10pct 5pct 2.5pct 1pct  
## critical values 0.119 0.146 0.176 0.216

ADF test for TCU in levels

ur.df(TCU, type = "drift", lags = 12, selectlags = "AIC")

##   
## ###############################################################   
## # Augmented Dickey-Fuller Test Unit Root / Cointegration Test #   
## ###############################################################   
##   
## The value of the test statistic is: -4.3317 9.4247

summary(ur.df(TCU, type = "drift", lags = 12, selectlags = "AIC"))

##   
## ###############################################   
## # Augmented Dickey-Fuller Test Unit Root Test #   
## ###############################################   
##   
## Test regression drift   
##   
##   
## Call:  
## lm(formula = z.diff ~ z.lag.1 + 1 + z.diff.lag)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -9.0715 -0.2835 0.0031 0.3087 3.5060   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.451429 0.568383 4.313 1.86e-05 \*\*\*  
## z.lag.1 -0.030736 0.007096 -4.332 1.71e-05 \*\*\*  
## z.diff.lag1 0.299697 0.038579 7.768 3.12e-14 \*\*\*  
## z.diff.lag2 -0.036453 0.040190 -0.907 0.36474   
## z.diff.lag3 0.050993 0.040271 1.266 0.20588   
## z.diff.lag4 0.075998 0.040268 1.887 0.05956 .   
## z.diff.lag5 0.013603 0.040320 0.337 0.73594   
## z.diff.lag6 0.072175 0.040160 1.797 0.07277 .   
## z.diff.lag7 0.009042 0.040176 0.225 0.82201   
## z.diff.lag8 -0.024710 0.040119 -0.616 0.53817   
## z.diff.lag9 0.060198 0.039991 1.505 0.13274   
## z.diff.lag10 0.114998 0.039966 2.877 0.00414 \*\*   
## z.diff.lag11 -0.056014 0.038782 -1.444 0.14912   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.6908 on 648 degrees of freedom  
## Multiple R-squared: 0.139, Adjusted R-squared: 0.123   
## F-statistic: 8.716 on 12 and 648 DF, p-value: 1.572e-15  
##   
##   
## Value of test-statistic is: -4.3317 9.4247   
##   
## Critical values for test statistics:   
## 1pct 5pct 10pct  
## tau2 -3.43 -2.86 -2.57  
## phi1 6.43 4.59 3.78

**PP test for TCU in levels**

ur.pp(TCU, type = "Z-alpha", lags = NULL)

##   
## ##################################################   
## # Phillips-Perron Unit Root / Cointegration Test #   
## ##################################################   
##   
## The value of the test statistic is: -21.0747

summary(ur.pp(TCU, type = "Z-alpha", lags = NULL))

##   
## ##################################   
## # Phillips-Perron Unit Root Test #   
## ##################################   
##   
## Test regression with intercept   
##   
##   
## Call:  
## lm(formula = y ~ y.l1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -10.0533 -0.2913 0.0605 0.3499 4.0605   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.495900 0.538405 2.778 0.00562 \*\*   
## y.l1 0.981132 0.006713 146.151 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.7353 on 671 degrees of freedom  
## Multiple R-squared: 0.9695, Adjusted R-squared: 0.9695   
## F-statistic: 2.136e+04 on 1 and 671 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic, type: Z-alpha is: -21.0747   
##   
## aux. Z statistics  
## Z-tau-mu 3.4315

**KPSS test for TCU in levels**

summary(ur.kpss(TCU, type = "tau", lags = NULL))

##   
## #######################   
## # KPSS Unit Root Test #   
## #######################   
##   
## Test is of type: tau with 6 lags.   
##   
## Value of test-statistic is: 0.1847   
##   
## Critical value for a significance level of:   
## 10pct 5pct 2.5pct 1pct  
## critical values 0.119 0.146 0.176 0.216

**ADF test for TCU in first differences**

ur.df(diff(TCU), type = "drift", lags = 12, selectlags = "AIC")

##   
## ###############################################################   
## # Augmented Dickey-Fuller Test Unit Root / Cointegration Test #   
## ###############################################################   
##   
## The value of the test statistic is: -6.6977 22.4326

summary(ur.df(diff(TCU), type = "drift", lags = 12, selectlags = "AIC"))

##   
## ###############################################   
## # Augmented Dickey-Fuller Test Unit Root Test #   
## ###############################################   
##   
## Test regression drift   
##   
##   
## Call:  
## lm(formula = z.diff ~ z.lag.1 + 1 + z.diff.lag)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -8.9181 -0.3030 0.0000 0.3092 3.9259   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.007766 0.027291 -0.285 0.7761   
## z.lag.1 -0.578597 0.086387 -6.698 4.6e-11 \*\*\*  
## z.diff.lag1 -0.121972 0.085776 -1.422 0.1555   
## z.diff.lag2 -0.169759 0.082679 -2.053 0.0405 \*   
## z.diff.lag3 -0.130129 0.079089 -1.645 0.1004   
## z.diff.lag4 -0.065957 0.075695 -0.871 0.3839   
## z.diff.lag5 -0.065383 0.072092 -0.907 0.3648   
## z.diff.lag6 -0.008407 0.067507 -0.125 0.9009   
## z.diff.lag7 -0.015737 0.062553 -0.252 0.8014   
## z.diff.lag8 -0.058333 0.055942 -1.043 0.2975   
## z.diff.lag9 -0.014925 0.047695 -0.313 0.7544   
## z.diff.lag10 0.082827 0.038891 2.130 0.0336 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.7008 on 648 degrees of freedom  
## Multiple R-squared: 0.3766, Adjusted R-squared: 0.366   
## F-statistic: 35.59 on 11 and 648 DF, p-value: < 2.2e-16  
##   
##   
## Value of test-statistic is: -6.6977 22.4326   
##   
## Critical values for test statistics:   
## 1pct 5pct 10pct  
## tau2 -3.43 -2.86 -2.57  
## phi1 6.43 4.59 3.78

**PP test for TCU in first differences**

ur.pp(diff(TCU), type = "Z-alpha", lags = NULL)

##   
## ##################################################   
## # Phillips-Perron Unit Root / Cointegration Test #   
## ##################################################   
##   
## The value of the test statistic is: -504.5475

summary(ur.pp(diff(TCU), type = "Z-alpha", lags = NULL))

##   
## ##################################   
## # Phillips-Perron Unit Root Test #   
## ##################################   
##   
## Test regression with intercept   
##   
##   
## Call:  
## lm(formula = y ~ y.l1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -9.0965 -0.3064 0.0076 0.3048 4.0215   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.008911 0.027311 -0.326 0.744   
## y.l1 0.283204 0.036944 7.666 6.27e-14 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.7078 on 670 degrees of freedom  
## Multiple R-squared: 0.08063, Adjusted R-squared: 0.07926   
## F-statistic: 58.76 on 1 and 670 DF, p-value: 6.268e-14  
##   
##   
## Value of test-statistic, type: Z-alpha is: -504.5475   
##   
## aux. Z statistics  
## Z-tau-mu -0.3307

**KPSS test for TCU in first differences**

summary(ur.kpss(diff(TCU), type = "tau", lags = "short"))

##   
## #######################   
## # KPSS Unit Root Test #   
## #######################   
##   
## Test is of type: tau with 6 lags.   
##   
## Value of test-statistic is: 0.0238   
##   
## Critical value for a significance level of:   
## 10pct 5pct 2.5pct 1pct  
## critical values 0.119 0.146 0.176 0.216