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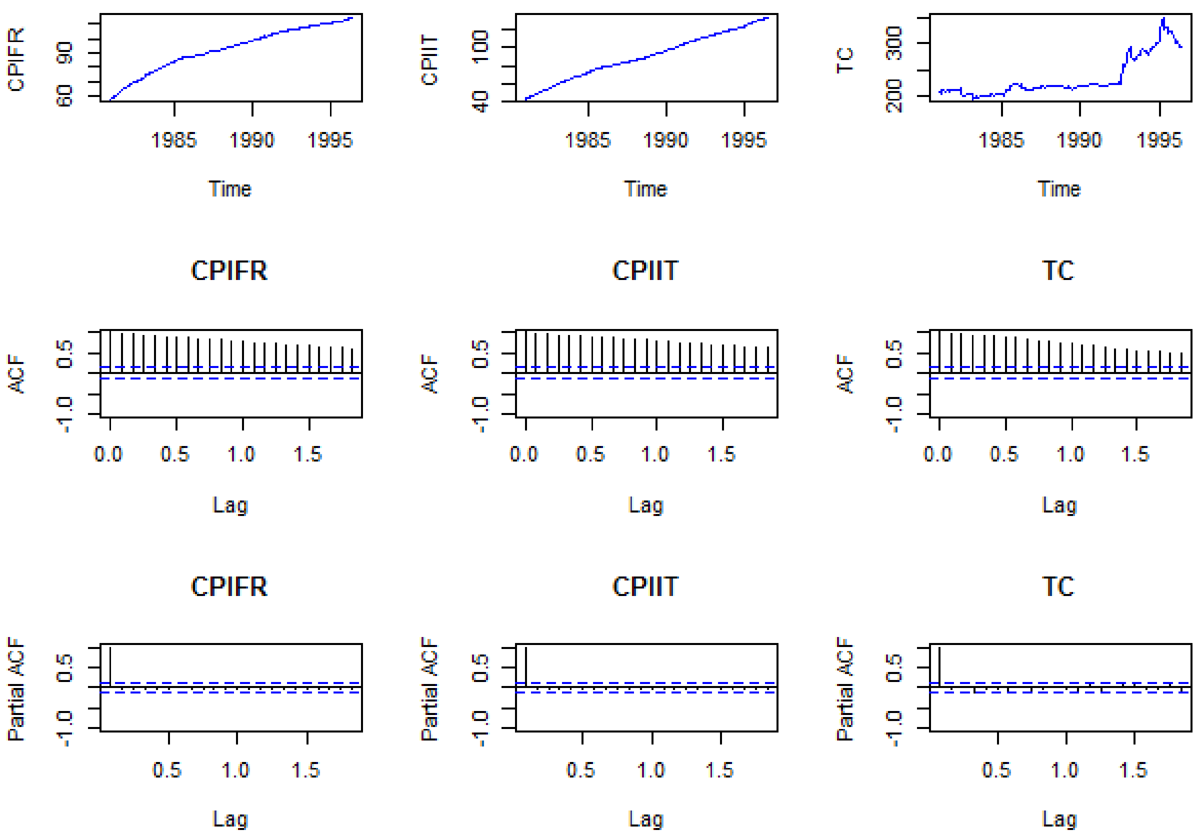
Practical Assignment 2 – SERIES TEMPORALES (Time Series)

1) **From the available data, analyzes what is the order of integration of log time series log(CPIFR), log(CPIIT) and log(TC).**

We begin by reading and viewing the data in its normal format.

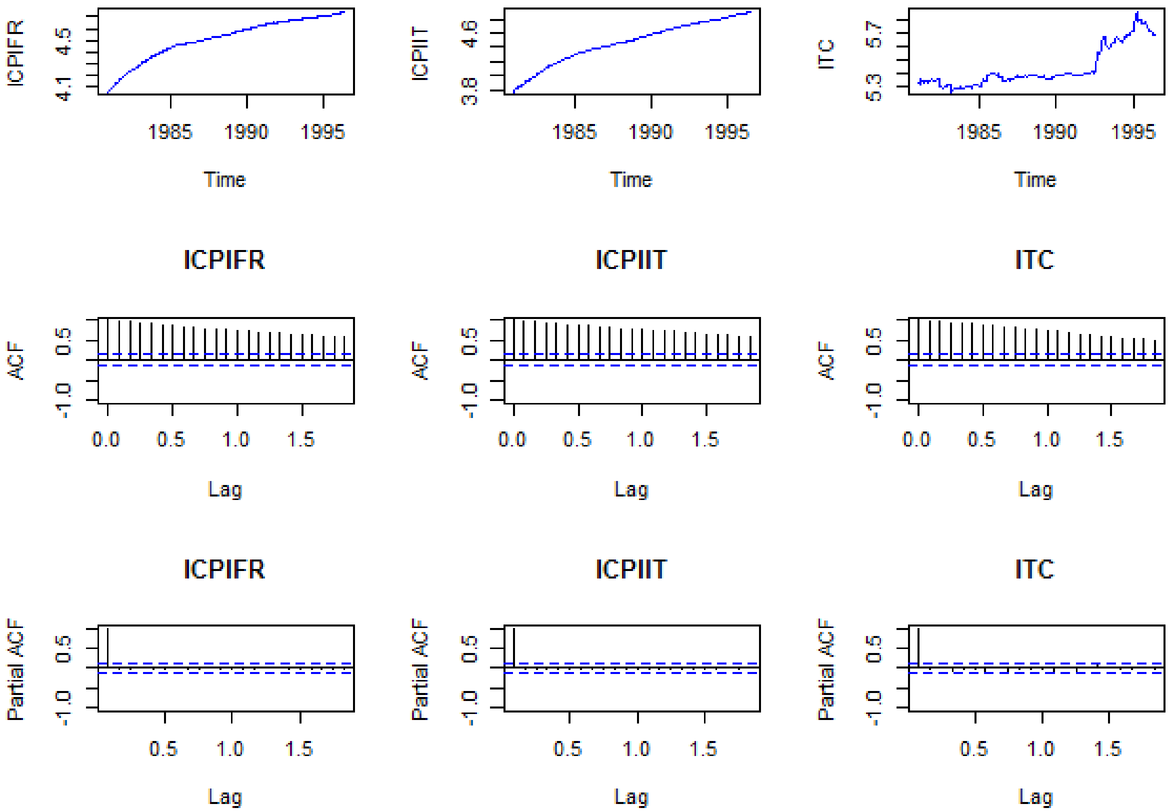
CPIFR	Índice de precios al consumo (Francia)	**<<-Consumer Price Index (France)**
CPIIT	Índice de precios al consumo (Italia)	**<<-Consumer Price Index (Italy)**
TC	Tipo de cambio Francia/Italia	**<<-Exchange France / Italy**

The data for CPIFR, CPIIT and TC is represented as followed:



Now we look at the logarithm of each series.

The data for log(CPIFR), log(CPIIT) and log(TC) is represented as followed:



Now we will look at the order of integration of each series from Dickey-Fuller Test:

1) **Serial log(CPIFR):**

```
> #France
> summary(ur.df(lCPIFR,"trend",lags=0))


###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt)

Residuals:
       Min         1Q     Median          3Q        Max
```

```
-0.0057981 -0.0013006  0.0000513  0.0012559  0.0058232

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.310e-01  1.310e-02  10.001  < 2e-16 ***
z.lag.1     -2.923e-02  3.100e-03  -9.428  < 2e-16 ***
tt           4.977e-05  1.009e-05   4.933 1.82e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.002074 on 182 degrees of freedom
Multiple R-squared:  0.6222,	Adjusted R-squared:  0.6181 
F-statistic: 149.9 on 2 and 182 DF,  p-value: < 2.2e-16


Value of test-statistic is: -9.4284 293.1805 149.8778 

Critical values for test statistics: 
      1pct  5pct 10pct
tau3 -3.99 -3.43 -3.13
phi2  6.22  4.75  4.07
phi3  8.43  6.49  5.47
```

We can see that the value of the statistic (`Value of test-statistic is: 149.8778`) is greater than the critical values of two tails (`phi3  8.43  6.49  5.47`) so, we reject Ho (meaning there is not a significant β).

Now looking at the "α" contrasted, `Value of test-statistic is: -9.4284,` is smaller than the critical values (`tau3 -3.99 -3.43 -3.13`). Therefore we reject Ho also.
This implying that TS model has no unit root I (0).

2) **Serial log(CPIIT):**

```
> #Italy
> summary(ur.df(lCPIIT,"trend",lags=0))

############################################### 
# Augmented Dickey-Fuller Test Unit Root Test # 
############################################### 

Test regression trend 


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt)

Residuals:
       Min         1Q     Median         3Q        Max 
-0.0080528 -0.0017951 -0.0003289  0.0015927  0.0096125 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.241e-01  1.353e-02   9.172  < 2e-16 ***
z.lag.1     -2.869e-02  3.415e-03  -8.403 1.22e-14 ***
tt           1.076e-04  1.881e-05   5.718 4.36e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 0.002681 on 182 degrees of freedom
Multiple R-squared:  0.5644,	Adjusted R-squared:  0.5597 
F-statistic: 117.9 on 2 and 182 DF,  p-value: < 2.2e-16


Value of test-statistic is: -8.4027 392.5903 117.9257 

Critical values for test statistics: 
      1pct  5pct 10pct
tau3 -3.99 -3.43 -3.13
phi2  6.22  4.75  4.07
phi3  8.43  6.49  5.47
```

We can see that the value of the statistic (`Value of test-statistic is: 117.9257`) is greater than the critical values of two tails (`phi3  8.43  6.49  5.47`) so, we reject Ho (meaning there is not a significant β).

Now looking at the "α" contrasted, `Value of test-statistic is: -8.4027,` is smaller than the critical values (`tau3 -3.99 -3.43 -3.13`). Therefore we reject Ho also.

This implying that TS model has no unit root I (0).

3) **Series log (TC):**

```
> #Fr&It Exchange
> summary(ur.df(lTC,"trend",lags=0))

############################################### 
# Augmented Dickey-Fuller Test Unit Root Test # 
############################################### 

Test regression trend 


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.062403 -0.007294 -0.002203  0.005041  0.144662 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  1.777e-01  9.374e-02   1.896   0.0596 .
z.lag.1     -3.407e-02  1.793e-02  -1.900   0.0591 .
tt           1.019e-04  4.946e-05   2.060   0.0408 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01985 on 182 degrees of freedom
Multiple R-squared:  0.02336,	Adjusted R-squared:  0.01262 
F-statistic: 2.176 on 2 and 182 DF,  p-value: 0.1164


Value of test-statistic is: -1.8996 2.013 2.1762 

Critical values for test statistics: 
```

```
      1pct  5pct 10pct
tau3 -3.99 -3.43 -3.13
phi2  6.22  4.75  4.07
phi3  8.43  6.49  5.47
```

After looking at the `summary(ur.df(lTC,"trend",lags=0))` we see that the statistic obtained from DF Test (`Value of test-statistic is: 2.1762`) is less than two-tailed critical values (`phi3  8.43  6.49  5.47`) and we cannot reject Ho (this means β is significant).

Since this is the case we continue to look at the other models.

```
> summary(ur.df(lTC,"drift",lags=0))

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression drift


Call:
lm(formula = z.diff ~ z.lag.1 + 1)

Residuals:
      Min        1Q    Median        3Q       Max
-0.067169 -0.006757 -0.001774  0.004349  0.150278

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.019700   0.054371   0.362    0.718
z.lag.1     -0.003274   0.009994  -0.328    0.744

Residual standard error: 0.02002 on 183 degrees of freedom
Multiple R-squared:  0.0005861,	Adjusted R-squared:  -0.004875
F-statistic: 0.1073 on 1 and 183 DF,  p-value: 0.7436


Value of test-statistic is: -0.3276 0.8824

Critical values for test statistics:
      1pct  5pct 10pct
tau2 -3.46 -2.88 -2.57
phi1  6.52  4.63  3.81
```

After looking at the `> summary(ur.df(lTC,"drift",lags=0))`we see that the statistic obtained from DF Test (`Value of test-statistic is: 0.8824)` is less than critical values (`phi1  6.52  4.63  3.81`) and we cannot reject Ho (this means β is significant).

We now look at the final summary.

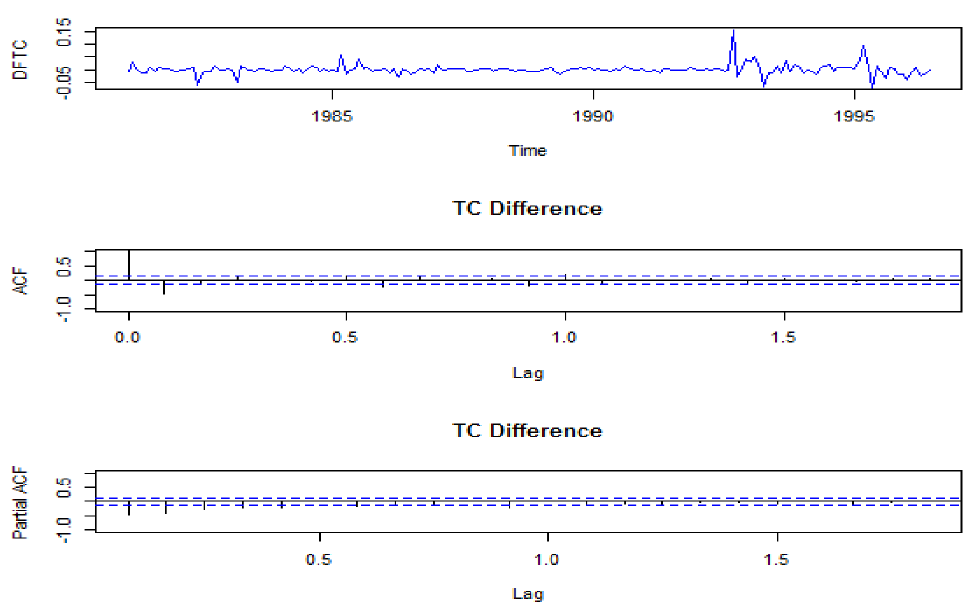
```
> summary(ur.df(lTC,"none",lags=0))

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
```

```
lm(formula = z.diff ~ z.lag.1 - 1)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.068662 -0.006464 -0.001441  0.004581  0.150390 

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
z.lag.1 0.0003458  0.0002699   1.281    0.202

Residual standard error: 0.01997 on 184 degrees of freedom
Multiple R-squared:  0.008841, Adjusted R-squared:  0.003454 
F-statistic: 1.641 on 1 and 184 DF,  p-value: 0.2018


Value of test-statistic is: 1.2811 

Critical values for test statistics: 
      1pct  5pct 10pct
tau1 -2.58 -1.95 -1.62
```

After looking at the `> summary(ur.df(lTC,"none",lags=0))` we see that the statistic obtained from DF Test (`Value of test-statistic is: 1.2811`) is less than critical values (`tau1 -2.58 -1.95 -1.62`) and we cannot reject Ho (this means β is significant).

Therefore we do not reject Ho in all cases is a clear indication that the model has a unit root. We will need to apply the DF test on the differentiated series for all models.

Now looking at the differentiated series, we represent the data as followed.



We now the DF test on the differentiated series:

```
> #Fr&It Exchange - Difference
> summary(ur.df(DFTC,"trend",lags=0))

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt)

Residuals:
      Min        1Q    Median        3Q       Max
-0.070368 -0.006090 -0.000969  0.004740  0.149280

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.392e-04  2.975e-03  -0.047    0.963
z.lag.1     -9.968e-01  7.433e-02 -13.411   <2e-16 ***
tt           2.241e-05  2.795e-05   0.802    0.424
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02009 on 181 degrees of freedom
Multiple R-squared:  0.4984,	Adjusted R-squared:  0.4929
F-statistic: 89.93 on 2 and 181 DF,  p-value: < 2.2e-16


Value of test-statistic is: -13.4109 59.9526 89.9288

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -3.99 -3.43 -3.13
phi2  6.22  4.75  4.07
phi3  8.43  6.49  5.47
```

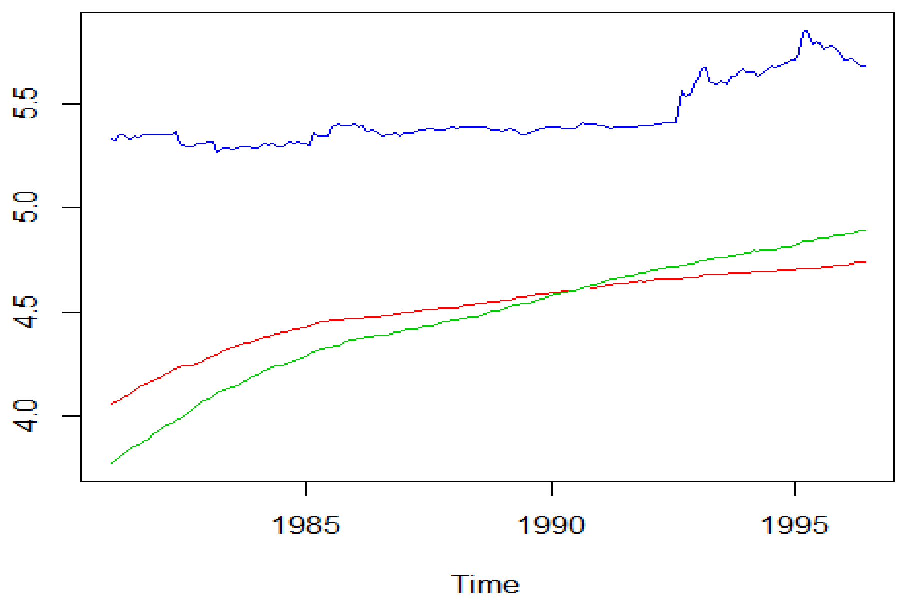
After looking at the `> summary(ur.df(DFTC,"trend",lags=0))` we see that the statistic obtained from DF Test (`Value of test-statistic is: 89.9288`) is greater critical values (`phi3  8.43  6.49  5.47`) so, we reject Ho (meaning there is not a significant β) therefore, the differenced model has no unit root.

Since the differentiated series has no unit root, the log (TC) is integrated of order 1, I (1).

2) **Considering the conclusions of the previous section check if these series are co-integrated or not.**

Please see below graphical representation of the log(CPIFR), log(CPIIT) and log(TC):

```
> #Log value of France, Italy and TC
> par(mfrow=c(1,1))
> ts.plot(lCPIFR,lCPIIT,lTC,col=c(2,3,4))
```



Note: log(CPIFR) is in red, log(CPIIT) is in green and log(TC) is in blue:

Now based on the previous section (#1) and the above graphical representation of the log series, we can say that the series are not cointegrated.

3) Explain what the consequences are the conclusion of above section regarding the theory of PPP.

According to The *Dictionary of Economics* published by *The Economist*, Wikipedia, and Investopedia, Purchasing-power parity theory (PPP) is a theory which states that the exchange rate between one currency and another is in equilibrium when their domestic purchasing powers at that rate of exchange are equivalent. It can also be said the final sum of quantities of goods and services produced in a country, the monetary value of a reference country.

This means that using the exchange rate of one currency to another can be drawn that the exchange rate of one currency markets not really determines the purchasing power of the currency with another. Therefore, exchange rates do not determine the standard of living or "real power" of a currency, but rather trading on the markets.

And since we have not found cointegration in (#2) of consumer prices indexes, this tells us that the change in price of a given goods and the exchange rate between the French currency and Italian currency have no direct relationship.