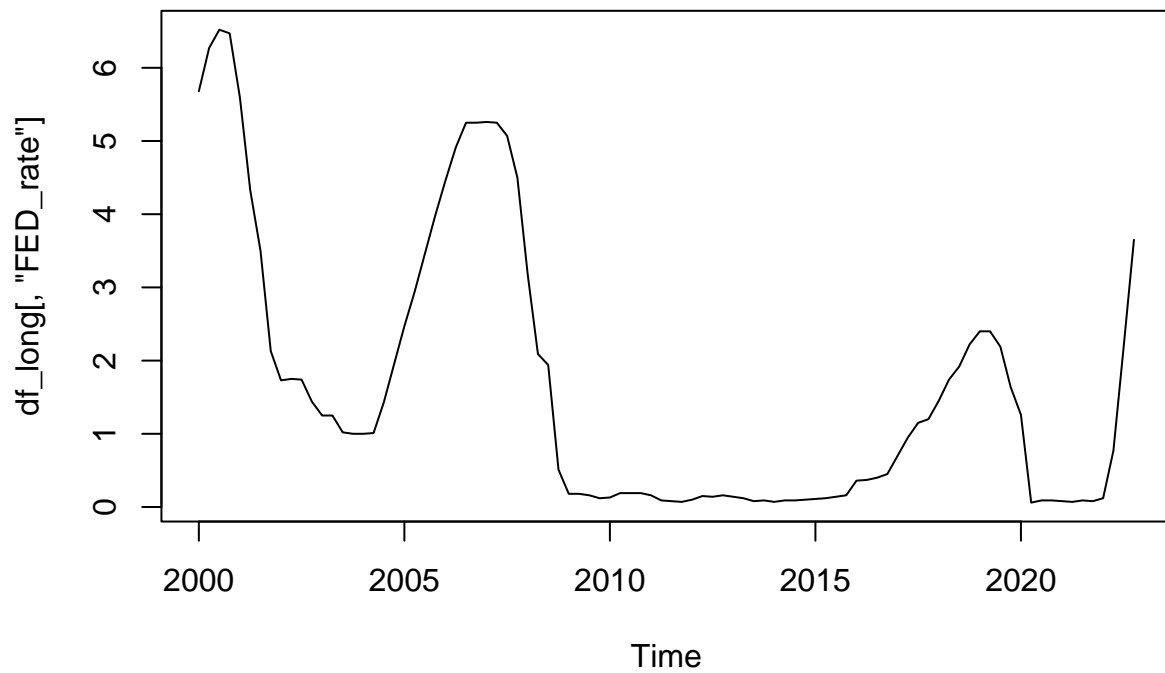


Homework Metrics 2b: Federal Reserve's interest rates and global outstanding credit. A univariate and multivariate analysis

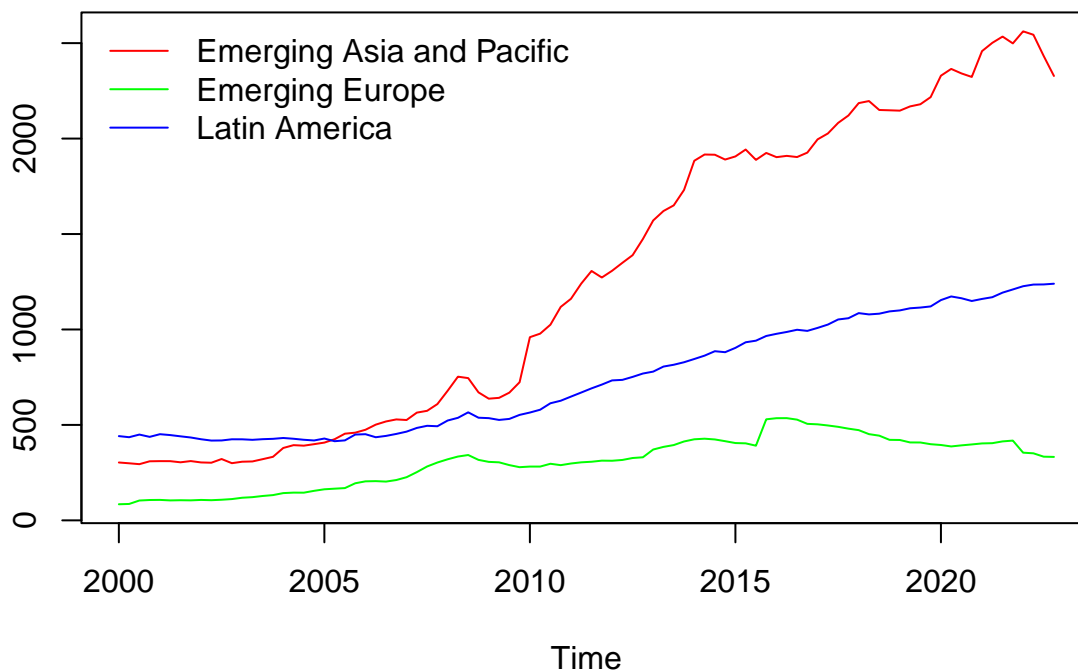
Valentin Auplat, Nino Laffray

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```
knitr::opts_chunk$set(  
  echo = TRUE,  
  warning = FALSE,  
  message = FALSE  
)
```



], c("Emerging Asia and Pacific", "Emerging Europe", "Latin A



```
library(urca)
library(zoo)
library(forecast)
df_long <- ts(df_long, start=c(2000, 1), end=c(2020, 1), frequency=4)
# 2.1 ADF Test (Augmented Dickey-Fuller)
adf_test <- ur.df(df_long[,c("FED_rate")], type = "trend", lags = 2) # Try "drift" or "none" too
summary(adf_test)
```

```
##
## #####
## # Augmented Dickey-Fuller Test Unit Root Test #
## #####
##
## Test regression trend
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.06709 -0.09487 -0.04901  0.13641  0.78742
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.221652   0.100899   2.197 0.031213 *
```

```
## z.lag.1      -0.087199    0.021263   -4.101 0.000106 ***
## tt          -0.002419    0.001702   -1.421 0.159586
## z.diff.lag1  0.543911    0.107517    5.059 3.04e-06 ***
## z.diff.lag2  0.228576    0.111798    2.045 0.044508 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2755 on 73 degrees of freedom
## Multiple R-squared:  0.5875, Adjusted R-squared:  0.5649
## F-statistic: 25.99 on 4 and 73 DF,  p-value: 2.066e-13
##
##
## Value of test-statistic is: -4.101 6.1243 8.8495
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -4.04 -3.45 -3.15
## phi2  6.50  4.88  4.16
## phi3  8.73  6.49  5.47
```

Although the visual plot of the FED rate shows distinct level shifts and prolonged flat regimes (e.g., 2008–2016), the ADF test result shows that the process is stationary once we control for trend and include appropriate lags.

This means the visual “non-stationarity” may be deterministic trend or policy-driven shifts, but not a stochastic unit root.

2.1 ADF Test (Augmented Dickey-Fuller)

```
adf_test <- ur.df(df_long[,c("Borrowers outside United States")], type = "trend", lags = 4) # Try "dri.
summary(adf_test)
```

```
##
## #####
## # Augmented Dickey-Fuller Test Unit Root Test #
## #####
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -351.00  -51.74   -5.20   53.39  280.03
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 195.92769   50.14905   3.907 0.000215 ***
## z.lag.1      -0.15726    0.04373  -3.596 0.000603 ***
## tt           22.90499    6.11895   3.743 0.000372 ***
## z.diff.lag1   0.12606    0.11464   1.100 0.275299
## z.diff.lag2   0.15902    0.11537   1.378 0.172561
## z.diff.lag3  -0.10185    0.11585  -0.879 0.382350
## z.diff.lag4   0.15692    0.11484   1.366 0.176243
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 105.6 on 69 degrees of freedom
## Multiple R-squared:  0.2617, Adjusted R-squared:  0.1975
## F-statistic: 4.076 on 6 and 69 DF,  p-value: 0.001478
##
##
## Value of test-statistic is: -3.5959 8.5744 7.9044
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -4.04 -3.45 -3.15
## phi2  6.50  4.88  4.16
## phi3  8.73  6.49  5.47
```

Idem.

2.2 PP Test (Phillips-Perron)

```
pp_test <- ur.pp(df_long[,c("FED_rate")], type = "Z-tau", model = "trend", lags = "short")
summary(pp_test)
```

```
##
## #####
## # Phillips-Perron Unit Root Test #
## #####
##
## Test regression with intercept and trend
##
##
## Call:
## lm(formula = y ~ y.l1 + trend)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.36072 -0.05078 -0.00721  0.20316  0.85922
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.016806   0.069540   0.242   0.810
## y.l1         0.959219   0.028752  33.361 <2e-16 ***
## trend        0.001395   0.002378   0.587   0.559
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4135 on 77 degrees of freedom
## Multiple R-squared:  0.9524, Adjusted R-squared:  0.9512
## F-statistic: 770.2 on 2 and 77 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: -2.0148
##
##      aux. Z statistics
## Z-tau-mu      -0.6875
## Z-tau-beta    -0.1999
##
```

```
## Critical values for Z statistics:
##           1pct      5pct      10pct
## critical values -4.075625 -3.465873 -3.159309

# 2.3 KPSS Test (Stationarity)
kpss_test <- ur.kpss(df_long[,c("FED_rate")], type = "tau", lags = "short")
summary(kpss_test)

##
## #####
## # KPSS Unit Root Test #
## #####
##
## Test is of type: tau with 3 lags.
##
## Value of test-statistic is: 0.1624
##
## Critical value for a significance level of:
##           10pct  5pct 2.5pct  1pct
## critical values 0.119 0.146 0.176 0.216
```