ARDL_MODEL()

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RYAN LITSWA r-markdown for the PANEL-ARDl() model

```
data <- read.csv("Countries.csv")
# Convert data to a panel data frame (replace 'Country' and 'Year' with your column names)
pdata <- pdata.frame(data, index = c("Country", "Year"))
```

Summary Statistics

```
summary(pdata)
```

```
##                Country         Year     Unemployment_Rate      GDP
##  Egypt             :31   1992   :  5   Min.   :0.02615   Min.   :1.769e+09
##  Kenya             :31   1993   :  5   1st Qu.:0.03810   1st Qu.:1.574e+10
##  Nigeria           :31   1994   :  5   Median :0.09860   Median :9.668e+10
##  Republic of Congo:31   1995   :  5   Mean   :0.11859   Mean   :1.600e+11
##  South Africa      :31   1996   :  5   3rd Qu.:0.19926   3rd Qu.:2.920e+11
##                          1997   :  5   Max.   :0.28840   Max.   :5.740e+11
##                          (Other):125
##       FDI             Population_Rate     Inflation
##  Min.   :-1.983e+09   Min.   :0.00388   Min.   :-0.00882
##  1st Qu.: 2.287e+08   1st Qu.:0.01977   1st Qu.: 0.04619
##  Median : 1.140e+09   Median :0.02383   Median : 0.07215
##  Mean   : 2.660e+09   Mean   :0.02306   Mean   : 0.09974
##  3rd Qu.: 4.298e+09   3rd Qu.:0.02736   3rd Qu.: 0.11379
##  Max.   : 4.066e+10   Max.   :0.04243   Max.   : 0.72835
##
```

Summary Statistics for Indivdual countries:

```
# Create a summary statistics table for each country
summary_by_country <- pdata %>%
  group_by(Country) %>%
  summarise(
    Mean_Unemployment_Rate = mean(Unemployment_Rate, na.rm = TRUE),
    SD_Unemployment_Rate = sd(Unemployment_Rate, na.rm = TRUE),
    Mean_GDP = mean(GDP, na.rm = TRUE),
    SD_GDP = sd(GDP, na.rm = TRUE),
    Mean_FDI = mean(FDI, na.rm = TRUE),
    SD_FDI = sd(FDI, na.rm = TRUE),
    Mean_Inflation = mean(Inflation, na.rm = TRUE),
    SD_Inflation = sd(Inflation, na.rm = TRUE),
    Mean_Population_Rate = mean(Population_Rate, na.rm = TRUE),
    SD_Population_Rate = sd(Population_Rate, na.rm = TRUE)
```

```
  )

# Print the summary statistics by country
print(summary_by_country)
```

```
## # A tibble: 5 x 11
##   Country  Mean_Unemployment_Rate SD_Unemployment_Rate Mean_GDP  SD_GDP Mean_FDI
##   <fct>                    <dbl>                <dbl>    <dbl>   <dbl>    <dbl>
## 1 Egypt                   0.0996              0.0184   1.85e11 1.26e11   4.29e9
## 2 Kenya                   0.0328              0.00926  4.29e10 3.50e10   3.75e8
## 3 Nigeria                 0.0410              0.00551  2.79e11 1.67e11   3.14e9
## 4 Republi~                0.202               0.00800  8.68e 9 5.74e 9   7.64e8
## 5 South A~                0.217               0.0258   2.84e11 1.12e11   4.73e9
## # i 5 more variables: SD_FDI <dbl>, Mean_Inflation <dbl>, SD_Inflation <dbl>,
## #   Mean_Population_Rate <dbl>, SD_Population_Rate <dbl>
```

Multiocollinearity test

```
# Check for multicollinearity using VIF
vif_model <- lm(Unemployment_Rate ~ GDP + FDI + Inflation + Population_Rate, data = pdata)
vif(vif_model)
```

```
##             GDP             FDI       Inflation Population_Rate
##        1.591556        1.383609        1.023912        1.357700
```

Step 1 Unit root test for stationarity

```
# STEP 1 Stationairy check for each varaible
#Im, Pesaran, and Shin (IPS) test for panel unit root
ips_unemployment <- purtest(pdata$Unemployment_Rate, test = "ips", exo = "intercept")

# JUST IF P-value not <0.05 for unemployment i tested earlier I(1) is the right one
diff_Unemployment <- diff(pdata$Unemployment_Rate)
ips_unemployment_diff <- purtest(diff_Unemployment, test = "ips", exo = "intercept")
```

```
## Warning in purtest(diff_Unemployment, test = "ips", exo = "intercept"): NA
## value(s) encountered and dropped, results may not be reliable
```

```
summary(ips_unemployment_diff)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## Automatic selection of lags using SIC: 0 - 4 lags (max: 10)
## statistic (Wtbar): -7.403
## p-value: 0
##
##                   lags obs        rho      trho       p.trho    mean   var
## Egypt                0  29 -0.7309515 -4.330654 3.878506e-04 -1.5248 0.793
## Kenya                0  29 -0.3029927 -2.257298 1.861992e-01 -1.5248 0.793
## Nigeria              4  25 -1.2125795 -2.941271 4.075427e-02 -1.3630 1.005
## Republic of Congo    1  28 -1.9860206 -5.889344 2.201282e-07 -1.5170 0.843
## South Africa         0  29 -1.2879104 -7.255803 6.616018e-11 -1.5248 0.793
```

```r
# IPS test for GDP
ips_GDP <- purtest(pdata$GDP, test= "ips", exo = "intercept")

#IF GDP p-value not <0.05 same for GDP I(1)
diff_gdp <- diff(pdata$GDP)
ips_gdp_diff <- purtest(diff_gdp, test = "ips",lags = 1, exo = "intercept")
```

```
## Warning in purtest(diff_gdp, test = "ips", lags = 1, exo = "intercept"): NA
## value(s) encountered and dropped, results may not be reliable
```

```r
summary(ips_gdp_diff)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## User-provided lags
## statistic (Wtbar): -4.797
## p-value: 0
##
##                   lags obs        rho      trho       p.trho   mean   var
## Egypt                1  28 -0.6852519 -3.166926 0.0220095108 -1.517 0.843
## Kenya                1  28 -0.4660732 -2.392980 0.1437183815 -1.517 0.843
## Nigeria              1  28 -0.8720308 -3.612629 0.0055523624 -1.517 0.843
## Republic of Congo    1  28 -1.0221412 -3.965797 0.0016053339 -1.517 0.843
## South Africa         1  28 -1.0602489 -4.295786 0.0004468051 -1.517 0.843
```

```r
# IPS TEST FOR FDI
ips_FDI <- purtest(pdata$FDI, test= "ips", exo = "intercept")
summary(ips_FDI)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## Automatic selection of lags using SIC: 0 - 0 lags (max: 10)
## statistic (Wtbar): -3.133
## p-value: 0.001
##
##                   lags obs        rho      trho       p.trho   mean   var
## Egypt                0  30 -0.1760005 -1.490035 5.389239e-01 -1.526 0.789
## Kenya                0  30 -0.3431427 -2.545625 1.046977e-01 -1.526 0.789
## Nigeria              0  30 -0.1425229 -1.434317 5.669852e-01 -1.526 0.789
## Republic of Congo    0  30 -0.6129167 -3.657826 4.772323e-03 -1.526 0.789
## South Africa         0  30 -0.8523709 -4.724265 7.229154e-05 -1.526 0.789
```

```r
#IF GDP p-value not <0.05 FOR FDI it is BOth I(0) and I(1)
diff_FDI <- diff(pdata$FDI)
ips_FDI_diff <- purtest(diff_FDI, test = "ips", exo = "intercept")
```

```
## Warning in purtest(diff_FDI, test = "ips", exo = "intercept"): NA value(s)
## encountered and dropped, results may not be reliable
```

```
summary(ips_FDI_diff)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## Automatic selection of lags using SIC: 0 - 5 lags (max: 10)
## statistic (Wtbar): -11.315
## p-value: 0
##
##                   lags obs        rho       trho       p.trho    mean    var
## Egypt                0  29 -0.8955274  -4.301327 4.369061e-04 -1.5248 0.7930
## Kenya                0  29 -1.1863623  -6.510719 6.433871e-09 -1.5248 0.7930
## Nigeria              0  29 -1.2173355  -5.996649 1.220450e-07 -1.5248 0.7930
## Republic of Congo    5  24 -3.2896058  -3.750304 3.477374e-03 -1.3434 1.0782
## South Africa         0  29 -1.8367152 -10.211024 6.959427e-20 -1.5248 0.7930
```

```
# IPS TEST FOR Population
ips_population <- purtest(pdata$Population_Rate, test= "ips", exo = "intercept")
```

```
## Warning in adj.ips.wtbar.value(x, y, exo = exo): lags should be an integer
## between 0 and 8
```

```
#IF GDP p-value not <0.05 for population it is I(1) and lags =1 was deliberately set to 1 for it to wor
diff_Population <- diff(pdata$Population_Rate)
ips_Population_diff <- purtest(diff_Population, test = "ips",lags = 1, exo = "intercept")
```

```
## Warning in purtest(diff_Population, test = "ips", lags = 1, exo = "intercept"):
## NA value(s) encountered and dropped, results may not be reliable
```

```
summary(ips_Population_diff)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## User-provided lags
## statistic (Wtbar): -6.426
## p-value: 0
##
##                   lags obs        rho      trho       p.trho   mean   var
## Egypt                1  28 -0.3525810 -2.303761 1.707775e-01 -1.517 0.843
## Kenya                1  28 -0.4209774 -2.704640 7.316687e-02 -1.517 0.843
## Nigeria              1  28 -0.4202771 -2.937813 4.112265e-02 -1.517 0.843
## Republic of Congo    1  28 -1.3163372 -6.056446 8.752517e-08 -1.517 0.843
## South Africa         1  28 -1.5709939 -6.774536 1.323978e-09 -1.517 0.843
```

```
# IPS TEST FOR INFLATION
ips_inflation <- purtest(pdata$Inflation, test= "ips", exo = "intercept")
summary(ips_inflation)
```

```
## Im-Pesaran-Shin Unit-Root Test
## Exogenous variables: Individual Intercepts
## Automatic selection of lags using SIC: 0 - 3 lags (max: 10)
```

```
## statistic (Wtbar): -4.579
## p-value: 0
##
##                    lags obs        rho      trho       p.trho   mean   var
## Egypt                 0  30 -0.5342383 -3.301543 0.0148418003 -1.526 0.789
## Kenya                 0  30 -0.5061153 -3.434549 0.0098685155 -1.526 0.789
## Nigeria               0  30 -0.2371858 -2.252989 0.1876699064 -1.526 0.789
## Republic of Congo     0  30 -0.7834617 -4.392085 0.0003013765 -1.526 0.789
## South Africa          3  27 -0.7398035 -3.423299 0.0102227237 -1.441 0.934
```

```
#Intresting that inflation is I(0) but only I(1) if lags=1 so i left it at just I(0)
```

Step 2 Lag-Length selection criteria

```
lag_selection <- VARselect(pdata[, c("Unemployment_Rate", "GDP", "FDI", "Inflation", "Population_Rate")])
lag_selection$selection
```

```
## AIC(n)  HQ(n)  SC(n) FPE(n)
##      4      1      1      4
```

```
# Display optimal lag lengths based on AIC, BIC, HQ
```

Step 3 Cointegration test

```
# Adjust ARDL model to include all variables
ardl_model <- dynlm(Unemployment_Rate ~ L(Unemployment_Rate, 1) +
                      L(GDP, 1) +
                      L(FDI, 1) +
                      L(Inflation, 1) +
                      L(Population_Rate, 1), data = pdata)

# Extract residuals
residuals <- resid(ardl_model)

# Test for cointegration (unit root test on residuals)
cointegration_test <- ur.df(residuals, type = "none")
summary(cointegration_test)
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression none
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -2.513e-17 -1.396e-18 -3.398e-19  1.850e-18  1.275e-17
```

```
##
## Coefficients:
##            Estimate Std. Error t value Pr(>|t|)
## z.lag.1    -1.00506    0.11598  -8.666 6.45e-15 ***
## z.diff.lag  0.07087    0.08617   0.822    0.412
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.186e-18 on 151 degrees of freedom
## Multiple R-squared:  0.4457, Adjusted R-squared:  0.4383
## F-statistic:  60.7 on 2 and 151 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -8.6657
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau1 -2.58 -1.95 -1.62
```

Now cointegration test Interpretation: The ADF test statistic value is -8.6657. With: 1% critical value: -2.58 5% critical value: -1.95 10% critical value: -1.62

Since the test statistic (-8.6657) is much more negative than all the critical values (for 1%, 5%, and 10% significance levels), we can reject the null hypothesis of no cointegration.

By rejecting the null hypothesis, we conclude that the residuals are stationary. This indicates that there is a long-run equilibrium relationship (cointegration) between Unemployment Rate, GDP, FDI, Inflation, and Population Rate.

In practical terms, despite short-term fluctuations, GDP, FDI, Inflation, Population Rate, and Unemployment Rate are tied together in the long term.

STEP 4 ECM

```r
countries <- unique(pdata$Country)
for (country in countries) {
  country_data <- subset(pdata, Country == country)
  ts_country <- ts(country_data[, -c(1, 2)], start = 1992, frequency = 1)

  # Estimate long-run model
  long_run_model <- dynlm(Unemployment_Rate ~ GDP + FDI + Inflation + Population_Rate, data = ts_country

  # Extract residuals
  residuals_long_run <- resid(long_run_model)

  # Estimate ECM
  ecm_model <- dynlm(d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
                       d(GDP) +
                       d(FDI) +
                       d(Inflation) +
                       d(Population_Rate) +
                       L(residuals_long_run, 1), data = ts_country)

  # View the summary for each country
  print(paste("ECM for", country))
```

```
  print(summary(ecm_model))
}
```

```
## [1] "ECM for Egypt"
##
## Time series regression with "ts" data:
## Start = 1993, End = 2022
##
## Call:
## dynlm(formula = d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
##     d(GDP) + d(FDI) + d(Inflation) + d(Population_Rate) + L(residuals_long_run,
##     1), data = ts_country)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.015181 -0.006390  0.002027  0.005411  0.016806
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)              -4.276e-03  1.289e-02  -0.332  0.74313
## L(Unemployment_Rate, 1)   6.517e-02  1.235e-01   0.528  0.60285
## d(GDP)                   -5.472e-14  7.414e-14  -0.738  0.46793
## d(FDI)                    1.650e-13  8.678e-13   0.190  0.85082
## d(Inflation)              1.938e-02  3.064e-02   0.632  0.53336
## d(Population_Rate)        8.510e+00  2.750e+00   3.094  0.00512 **
## L(residuals_long_run, 1) -4.766e-01  2.001e-01  -2.382  0.02589 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.008795 on 23 degrees of freedom
## Multiple R-squared:  0.5039, Adjusted R-squared:  0.3745
## F-statistic: 3.894 on 6 and 23 DF,  p-value: 0.007897
##
## [1] "ECM for Kenya"
##
## Time series regression with "ts" data:
## Start = 1993, End = 2022
##
## Call:
## dynlm(formula = d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
##     d(GDP) + d(FDI) + d(Inflation) + d(Population_Rate) + L(residuals_long_run,
##     1), data = ts_country)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0039907 -0.0009785 -0.0000466  0.0005785  0.0046020
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)              -4.437e-03  2.017e-03  -2.200   0.0381 *
## L(Unemployment_Rate, 1)   1.454e-01  6.335e-02   2.295   0.0312 *
## d(GDP)                    2.328e-13  1.563e-13   1.489   0.1500
## d(FDI)                   -1.542e-12  1.351e-12  -1.142   0.2653
```

```
## d(Inflation)              5.582e-03  4.965e-03   1.124   0.2725
## d(Population_Rate)        3.518e-01  6.414e-01   0.548   0.5887
## L(residuals_long_run, 1) -2.728e-01  1.209e-01  -2.255   0.0339 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.002358 on 23 degrees of freedom
## Multiple R-squared:  0.3714, Adjusted R-squared:  0.2074
## F-statistic: 2.265 on 6 and 23 DF,  p-value: 0.0729
##
## [1] "ECM for Nigeria"
##
## Time series regression with "ts" data:
## Start = 1993, End = 2022
##
## Call:
## dynlm(formula = d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
##     d(GDP) + d(FDI) + d(Inflation) + d(Population_Rate) + L(residuals_long_run,
##     1), data = ts_country)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0102633 -0.0012112 -0.0001849  0.0010238  0.0051954
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)               5.953e-03  8.045e-03   0.740    0.467
## L(Unemployment_Rate, 1)  -1.398e-01  1.957e-01  -0.714    0.482
## d(GDP)                   -1.282e-14  1.435e-14  -0.893    0.381
## d(FDI)                    7.758e-13  4.845e-13   1.601    0.123
## d(Inflation)              4.822e-03  5.745e-03   0.839    0.410
## d(Population_Rate)       -2.121e+00  1.873e+00  -1.132    0.269
## L(residuals_long_run, 1) -1.174e-01  4.117e-01  -0.285    0.778
##
## Residual standard error: 0.003146 on 23 degrees of freedom
## Multiple R-squared:  0.2775, Adjusted R-squared:  0.08904
## F-statistic: 1.472 on 6 and 23 DF,  p-value: 0.2315
##
## [1] "ECM for Republic of Congo"
##
## Time series regression with "ts" data:
## Start = 1993, End = 2022
##
## Call:
## dynlm(formula = d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
##     d(GDP) + d(FDI) + d(Inflation) + d(Population_Rate) + L(residuals_long_run,
##     1), data = ts_country)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0151153 -0.0022970 -0.0006778  0.0019748  0.0152523
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)              -3.179e-02  5.783e-02  -0.550    0.588
## L(Unemployment_Rate, 1)   1.595e-01  2.856e-01   0.558    0.582
## d(GDP)                   -5.779e-13  6.704e-13  -0.862    0.398
## d(FDI)                   -2.790e-14  6.621e-13  -0.042    0.967
## d(Inflation)              2.089e-04  1.092e-02   0.019    0.985
## d(Population_Rate)       -1.025e-01  2.220e-01  -0.462    0.649
## L(residuals_long_run, 1) -5.619e-01  3.589e-01  -1.566    0.131
##
## Residual standard error: 0.0056 on 23 degrees of freedom
## Multiple R-squared:  0.3175, Adjusted R-squared:  0.1395
## F-statistic: 1.783 on 6 and 23 DF,  p-value: 0.1471
##
## [1] "ECM for South Africa"
##
## Time series regression with "ts" data:
## Start = 1993, End = 2022
##
## Call:
## dynlm(formula = d(Unemployment_Rate) ~ L(Unemployment_Rate, 1) +
##     d(GDP) + d(FDI) + d(Inflation) + d(Population_Rate) + L(residuals_long_run,
##     1), data = ts_country)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0250002 -0.0034779  0.0001198  0.0041100  0.0146344
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)              -6.612e-02  2.150e-02  -3.075  0.00536 **
## L(Unemployment_Rate, 1)   3.107e-01  9.852e-02   3.154  0.00444 **
## d(GDP)                    7.259e-14  5.043e-14   1.439  0.16349
## d(FDI)                    7.268e-13  1.965e-13   3.698  0.00119 **
## d(Inflation)             -6.002e-02  7.329e-02  -0.819  0.42118
## d(Population_Rate)       -7.814e-01  5.302e-01  -1.474  0.15406
## L(residuals_long_run, 1) -4.117e-01  1.452e-01  -2.835  0.00938 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.008455 on 23 degrees of freedom
## Multiple R-squared:  0.5244, Adjusted R-squared:  0.4003
## F-statistic: 4.227 on 6 and 23 DF,  p-value: 0.005204
```

Key Takeaways:

Error Correction Term: Significant in Egypt, Kenya, and South Africa, indicating the system adjusts toward long-run equilibrium in these countries.

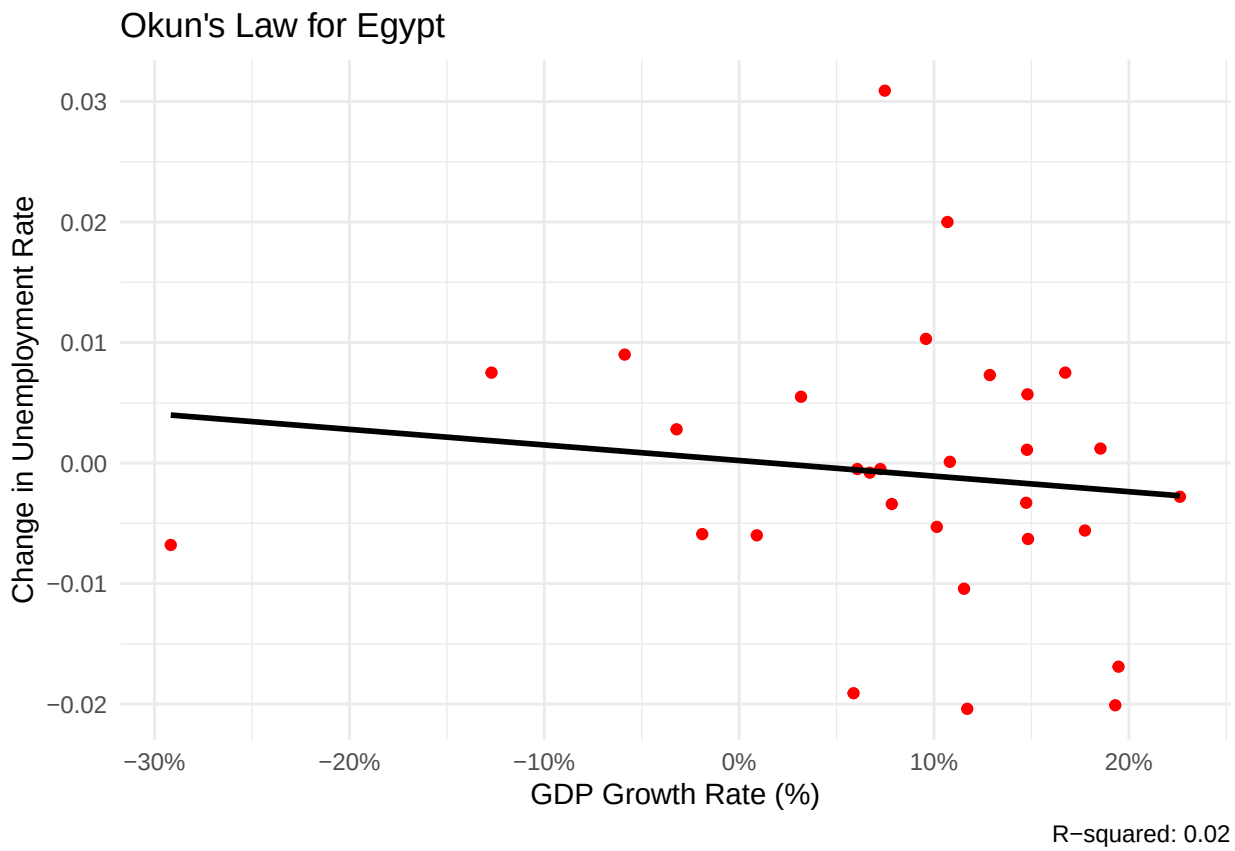
Short-Run Variables: Population growth significantly affects unemployment in Egypt, and FDI has a strong impact in South Africa.

Unemployment Persistence: Lagged unemployment is significant in Kenya and South Africa, indicating that unemployment tends to persist over time in these countries.

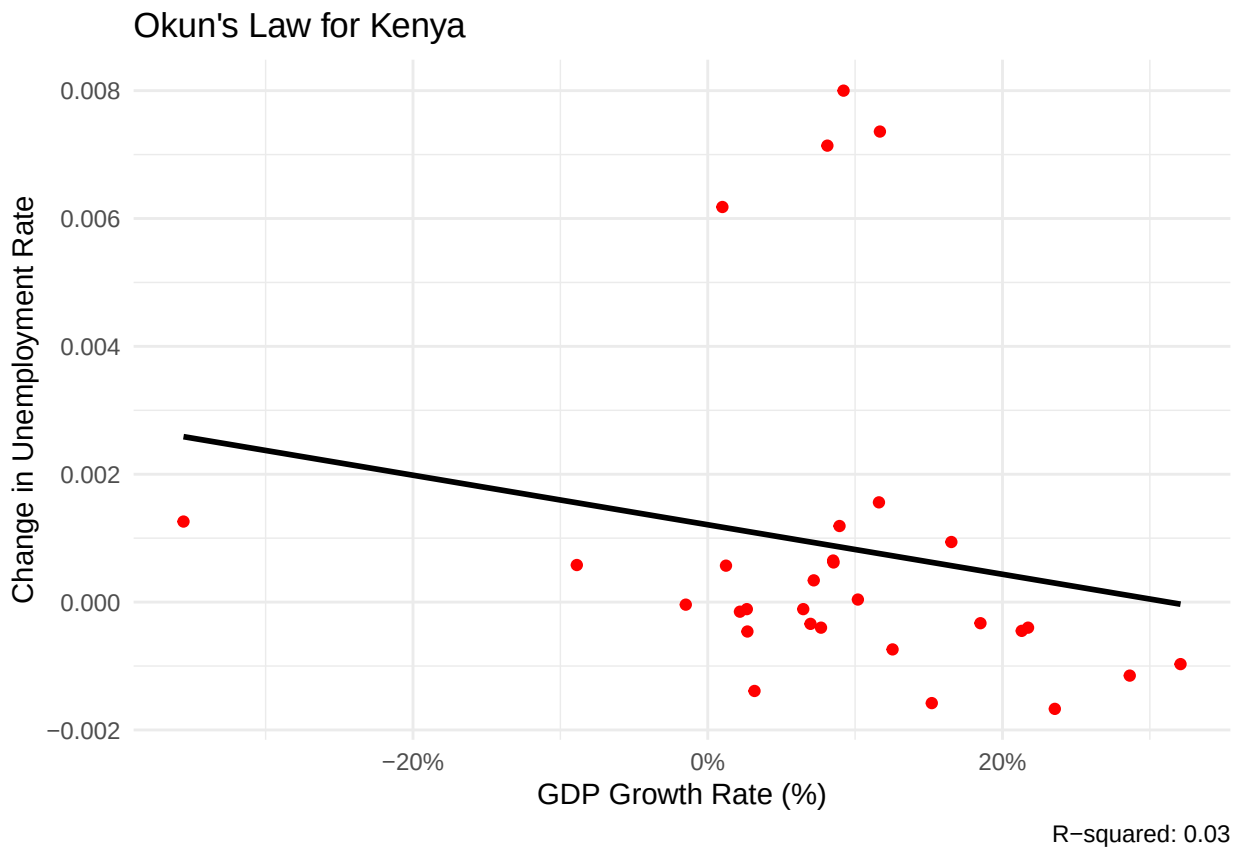
OKUN'LAW GRAPH

```r
# Create a data frame to store the results
okun_results <- data.frame(Country = character(),
                           Slope = numeric(),
                           Intercept = numeric(),
                           R_squared = numeric(),
                           stringsAsFactors = FALSE)

# Loop over each country to calculate changes and run the regression
for (country in countries) {
  # Subset the data for each country
  country_data <- subset(pdata, Country == country)

  # Convert country data to a regular data frame to avoid pseries issues
  country_data <- as.data.frame(country_data)

  # Calculate the change in unemployment and the GDP growth rate
  country_data$diff_unemployment <- as.numeric(diff(country_data$Unemployment_Rate))
  country_data$gdp_growth_rate <- 100 * diff(log(country_data$GDP))  # Calculate GDP growth rate in per

  # Remove NA values that result from differencing
  country_data <- na.omit(country_data)

  # Run the linear regression (Change in Unemployment Rate ~ GDP Growth Rate)
  okun_model <- lm(diff_unemployment ~ gdp_growth_rate, data = country_data)

  # Extract the regression results
  slope <- coef(okun_model)[2]
  intercept <- coef(okun_model)[1]
  r_squared <- summary(okun_model)$r.squared

  # Store the results in the data frame
  okun_results <- rbind(okun_results, data.frame(Country = country,
                                                 Slope = slope,
                                                 Intercept = intercept,
                                                 R_squared = r_squared))

  # Create a scatter plot with a regression line
  plot <- ggplot(country_data, aes(x = gdp_growth_rate, y = diff_unemployment)) +
    geom_point(color = "red") +
    geom_smooth(method = "lm", se = FALSE, color = "black") +
    labs(title = paste("Okun's Law for", country),
         x = "GDP Growth Rate (%)",
         y = "Change in Unemployment Rate",
         caption = paste("R-squared:", round(r_squared, 2))) +
    theme_minimal() +
    scale_x_continuous(labels = scales::percent_format(scale = 1))  # Format X-axis as percentage

  # Print the plot for each country
  print(plot)
}
```

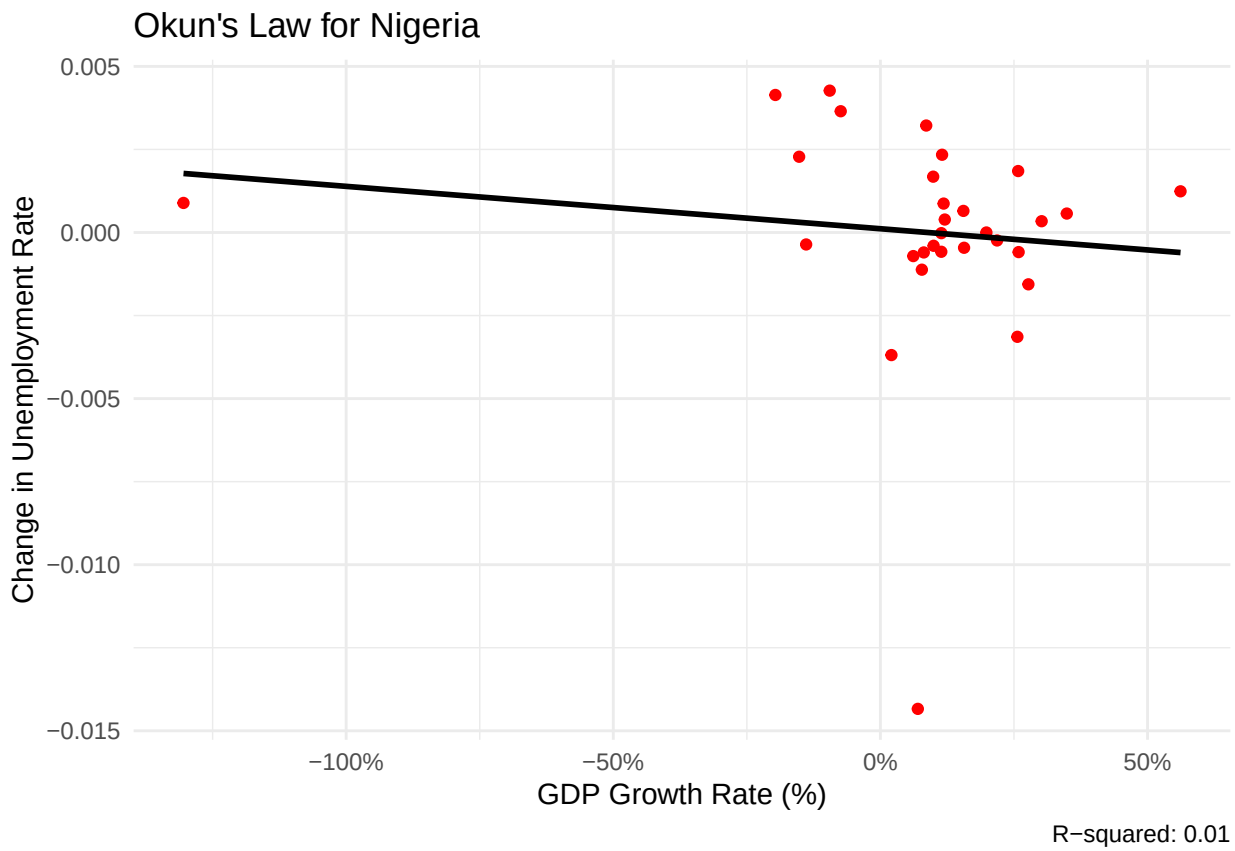
```
## `geom_smooth()` using formula = 'y ~ x'
```



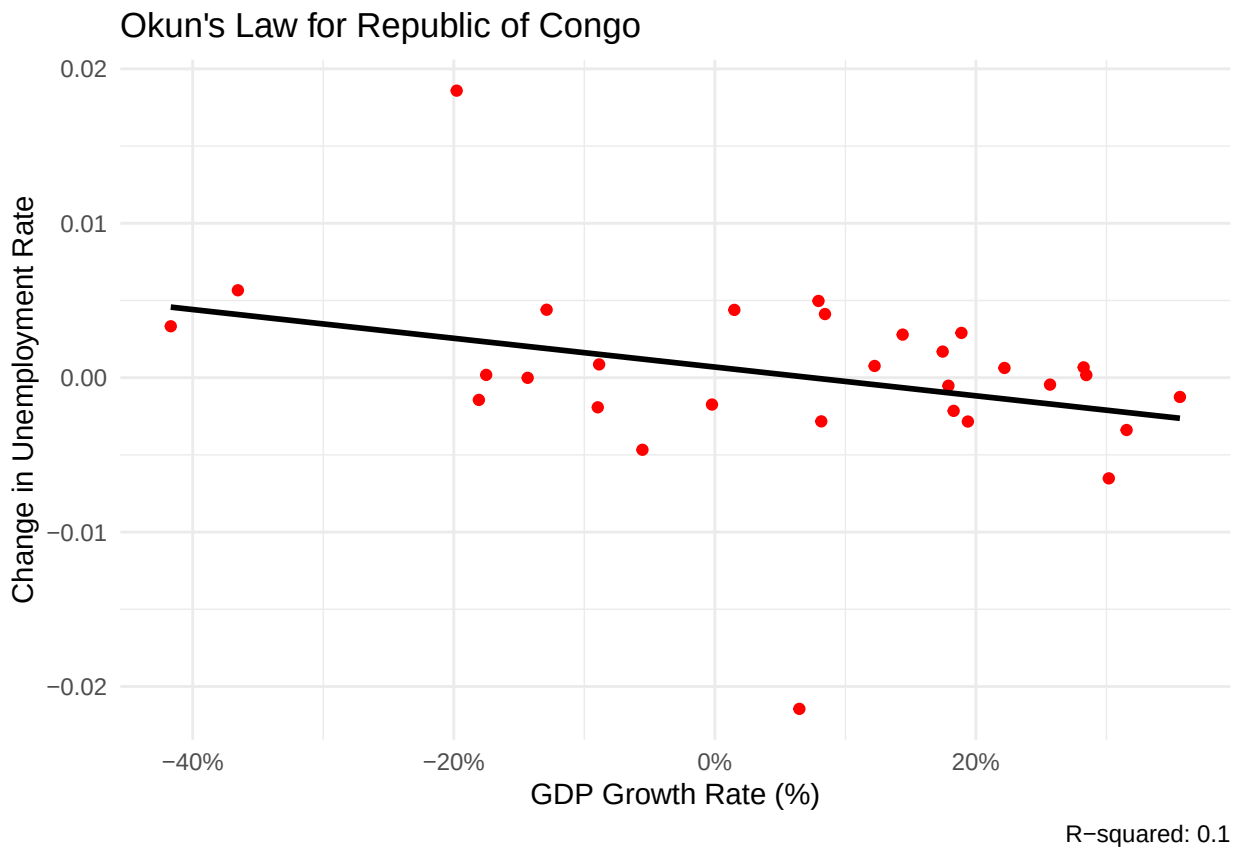

```
## `geom_smooth()` using formula = 'y ~ x'
```



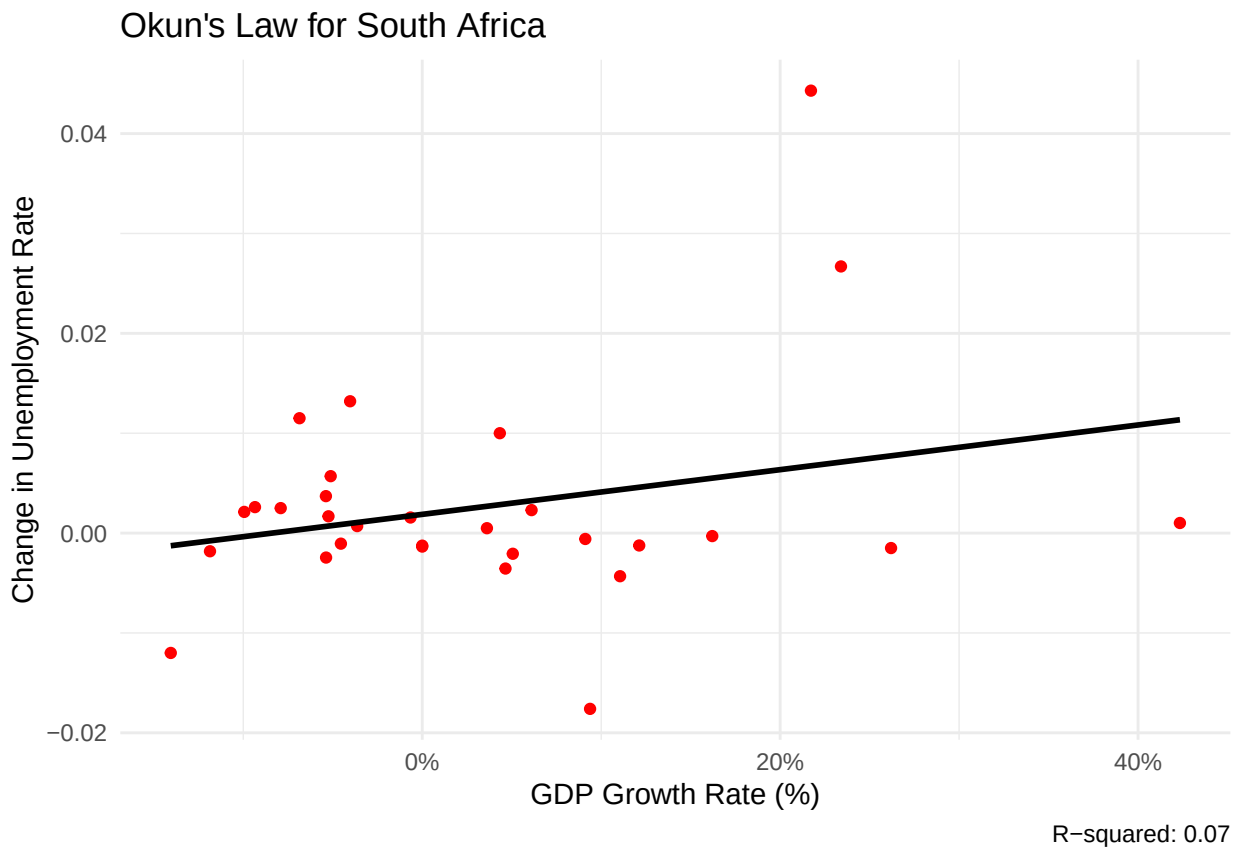

```
## `geom_smooth()` using formula = 'y ~ x'
```




```
## `geom_smooth()` using formula = 'y ~ x'
```




```
## `geom_smooth()` using formula = 'y ~ x'
```




```
# View the Okun's Law results summary for all countries
print(okun_results)
```

```
##                            Country         Slope    Intercept  R_squared
## gdp_growth_rate              Egypt -1.292854e-04 0.0002076258 0.01548348
## gdp_growth_rate1             Kenya -3.873249e-05 0.0012098736 0.03223942
## gdp_growth_rate2           Nigeria -1.275900e-05 0.0001128524 0.01391063
## gdp_growth_rate3 Republic of Congo -9.313137e-05 0.0006874160 0.09797549
## gdp_growth_rate4      South Africa  2.237141e-04 0.0018759197 0.06906475
```