Suriname Sovereign Wealth Fund Model

Preliminary Technical Report

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Contents

About this document

This document represents a preview of an ongoing research project. The content included herein reflects a selection of material drawn from the full research study and is provided solely for demonstration and review purposes. The remaining sections of the study are currently under development. All findings, analyses, and conclusions presented in this preliminary version are provisional subject to refinement in the final publication.

Introduction

This technical report presents a focused analysis with fully reproducible R code, providing a transparent and systematic approach to the data and results. It it part of the main report, which readers are encouraged to consult for additional context and background information. All analyses here have been conducted in R, ensuring that workflows, visualizations, and computations can be reproduced and extended as needed.

PHASE B - Exploration

In phase B the data will be pulled into R and tidy it so in later phases (descriptive analysis, modelling, policy scenarios) it will run smoothly. The data is loaded and inspected from IMF WEO (World Economic Outlook). The countries of interest for comparisons are: Suriname, Norway, Timor-Leste, Ghana, Guyana and Azerbaijan.

```
# Step 1. Load and inspect IMF WEO (WORLD ECONOMIC OUTLOOK) data

library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.1     v stringr   1.5.2
## v ggplot2   4.0.0     v tibble    3.3.0
## v lubridate 1.9.4     v tidyr     1.3.1
## v purrr     1.1.0
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(tidyr)
library(ggplot2)
library(countrycode)
library(dplyr)
library(readxl)
library(janitor)
```

```
##
## Attaching package: 'janitor'
##
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```
## Rows: 8,626
## Columns: 61
## $ `WEO Country Code`              <dbl> 512, 512, 512, 512, 512, 512, 512, 512~
## $ ISO                             <chr> "AFG", "AFG", "AFG", "AFG", "AFG", "AF~
## $ `WEO Subject Code`              <chr> "NGDP_R", "NGDP_RPCH", "NGDP", "NGDPD"~
## $ Country                         <chr> "Afghanistan", "Afghanistan", "Afghani~
## $ `Subject Descriptor`            <chr> "Gross domestic product, constant pric~
```

```
## $ `Subject Notes`                 <chr> "Expressed in billions of national cur~
## $ Units                           <chr> "National currency", "Percent change",~
## $ Scale                           <chr> "Billions", "Units", "Billions", "Bill~
## $ `Country/Series-specific Notes` <chr> "Source: National Statistics Office La~
## $ `1980`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1981`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1982`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1983`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1984`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1985`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1986`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1987`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1988`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1989`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1990`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1991`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1992`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1993`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1994`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1995`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1996`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1997`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1998`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `1999`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2000`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2001`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2002`                          <chr> "453.48399999999998", "n/a", "178.756"~
## $ `2003`                          <chr> "492.90300000000002", "8.6920000000000~
## $ `2004`                          <chr> "496.209", "0.67100000000000004", "246~
## $ `2005`                          <chr> "554.91", "11.83", "304.92599999999999~
## $ `2006`                          <chr> "584.65800000000002", "5.3609999999999~
## $ `2007`                          <chr> "662.65", "13.34", "427.495", "8.55599~
## $ `2008`                          <chr> "688.24699999999996", "3.863", "517.50~
## $ `2009`                          <chr> "829.92399999999998", "20.585000000000~
## $ `2010`                          <chr> "899.95600000000002", "8.4380000000000~
## $ `2011`                          <chr> "958.26599999999996", "6.4790000000000~
## $ `2012`                          <chr> "1092.1179999999999", "13.968", "1033.~
## $ `2013`                          <chr> "1154.1780000000001", "5.6829999999999~
## $ `2014`                          <chr> "1185.306", "2.6970000000000001", "118~
## $ `2015`                          <chr> "1197.0119999999999", "0.9879999999999~
## $ `2016`                          <chr> "1222.9169999999999", "2.1640000000000~
## $ `2017`                          <chr> "1255.288", "2.6469999999999998", "128~
## $ `2018`                          <chr> "1270.2159999999999", "1.1890000000000~
## $ `2019`                          <dbl> 1319.902, 3.912, 1469.596, 18.876, 97.~
## $ `2020`                          <chr> "1288.8689999999999", "-2.351", "1547.~
## $ `2021`                          <chr> "1101.4449999999999", "-14.542", "1251~
## $ `2022`                          <chr> "1032.712", "-6.24", "1283.442", "14.5~
## $ `2023`                          <chr> "1056.123", "2.2669999999999999", "135~
## $ `2024`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2025`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2026`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2027`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2028`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `2029`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
```

```
## $ `2030`                          <chr> "n/a", "n/a", "n/a", "n/a", "n/a", "n/~
## $ `Estimates Start After`         <dbl> 2024, 2024, 2024, 2024, 2024, 2024, 20~
```

```
## # A tibble: 44 x 3
##    weo_subject_code subject_descriptor                                  n
##    <chr>            <chr>                                           <int>
##  1 BCA              Current account balance                            31
##  2 BCA_NGDPD        Current account balance                            31
##  3 GGR              General government revenue                         31
##  4 GGR_NGDP         General government revenue                         31
##  5 GGSB             General government structural balance              31
##  6 GGSB_NPGDP       General government structural balance              31
##  7 GGX              General government total expenditure               31
##  8 GGXCNL           General government net lending/borrowing           31
##  9 GGXCNL_NGDP      General government net lending/borrowing           31
## 10 GGXONLB          General government primary net lending/borrowing   31
## # i 34 more rows
```

The following table contains all the (raw) data for the countries of interest.

```
weo_core
```

```
## # A tibble: 2,754 x 19
##    weo_country_code iso   country   subject_descriptor subject_notes units scale
##               <dbl> <chr> <chr>     <chr>              <chr>         <chr> <chr>
##  1              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  2              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  3              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  4              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  5              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  6              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  7              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  8              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
##  9              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
## 10              912 AZE   Azerbaij~ Gross domestic pr~ Annual perce~ Perc~ Units
## # i 2,744 more rows
## # i 12 more variables: country_series_specific_notes <chr>,
## #   estimates_start_after <dbl>, year <int>, gdp_growth <dbl>,
## #   gdp_current_usd <dbl>, gdp_percap_usd <dbl>, inflation <dbl>,
## #   export_growth <dbl>, gov_revenue_gdp <dbl>, gov_expenditure_gdp <dbl>,
## #   gov_debt_gdp <dbl>, current_account_gdp <dbl>
```

This is where the data coverage for Suriname is being checked.

```
#checking coverage for Suriname (what is missing)
library(naniar)
weo_core %>%
  filter(country == "Suriname") %>%
  miss_var_summary()
```

```
## # A tibble: 19 x 3
##    variable                    n_miss pct_miss
```

```
##    <chr>                           <int>    <num>
##  1 gdp_percap_usd                    418     91.1
##  2 gov_revenue_gdp                   418     91.1
##  3 gov_expenditure_gdp               418     91.1
##  4 gov_debt_gdp                      418     91.1
##  5 gdp_growth                        408     88.9
##  6 gdp_current_usd                   408     88.9
##  7 inflation                         408     88.9
##  8 export_growth                     408     88.9
##  9 current_account_gdp               408     88.9
## 10 weo_country_code                    0      0
## 11 iso                                 0      0
## 12 country                             0      0
## 13 subject_descriptor                  0      0
## 14 subject_notes                       0      0
## 15 units                               0      0
## 16 scale                               0      0
## 17 country_series_specific_notes       0      0
## 18 estimates_start_after               0      0
## 19 year                                0      0
```

Data table for Suriname only.

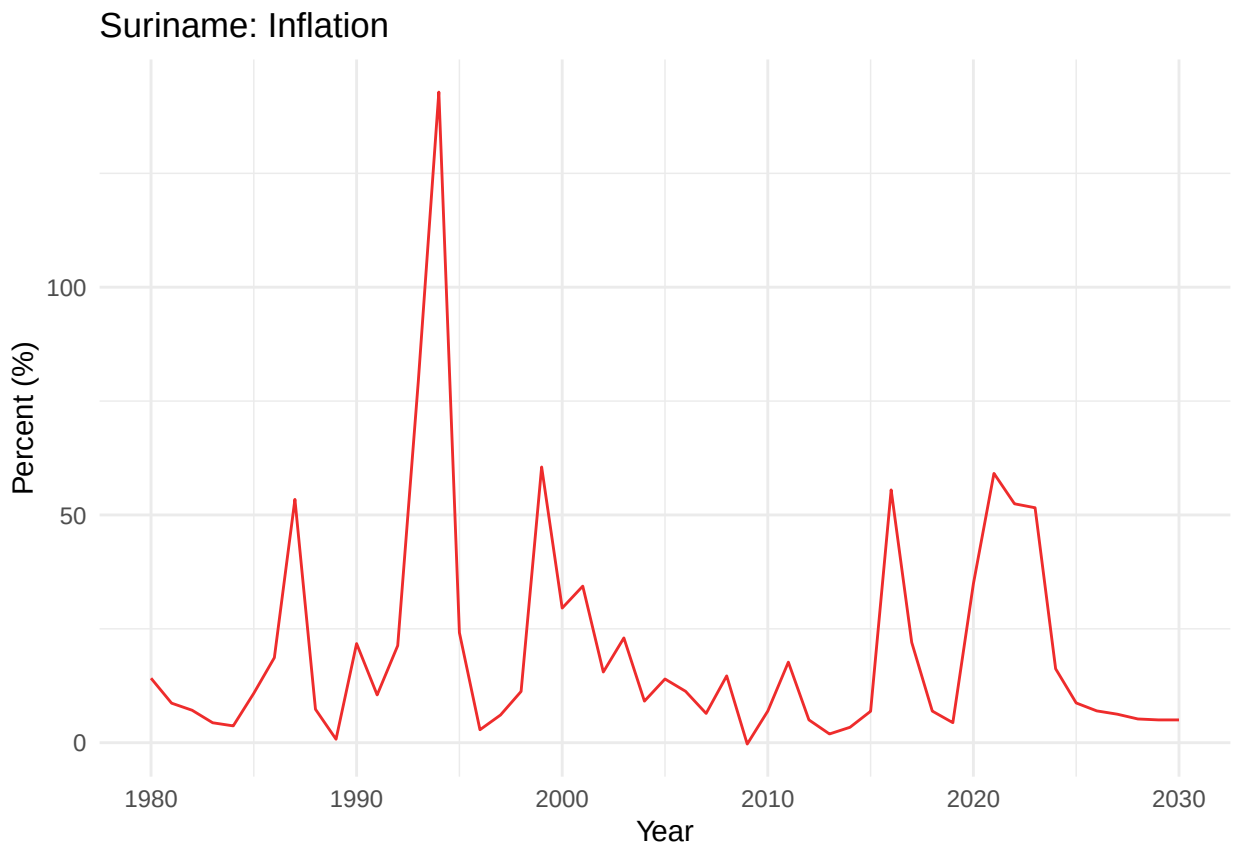
```
# Focus only on Suriname
sur <- weo_core %>% filter(country == "Suriname")
sur
```

```
## # A tibble: 459 x 19
##    weo_country_code iso   country  subject_descriptor  subject_notes units scale
##               <dbl> <chr> <chr>    <chr>               <chr>         <chr> <chr>
##  1              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  2              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  3              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  4              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  5              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  6              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  7              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  8              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
##  9              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
## 10              366 SUR   Suriname Gross domestic pro~ Annual perce~ Perc~ Units
## # i 449 more rows
## # i 12 more variables: country_series_specific_notes <chr>,
## #   estimates_start_after <dbl>, year <int>, gdp_growth <dbl>,
## #   gdp_current_usd <dbl>, gdp_percap_usd <dbl>, inflation <dbl>,
## #   export_growth <dbl>, gov_revenue_gdp <dbl>, gov_expenditure_gdp <dbl>,
## #   gov_debt_gdp <dbl>, current_account_gdp <dbl>
```

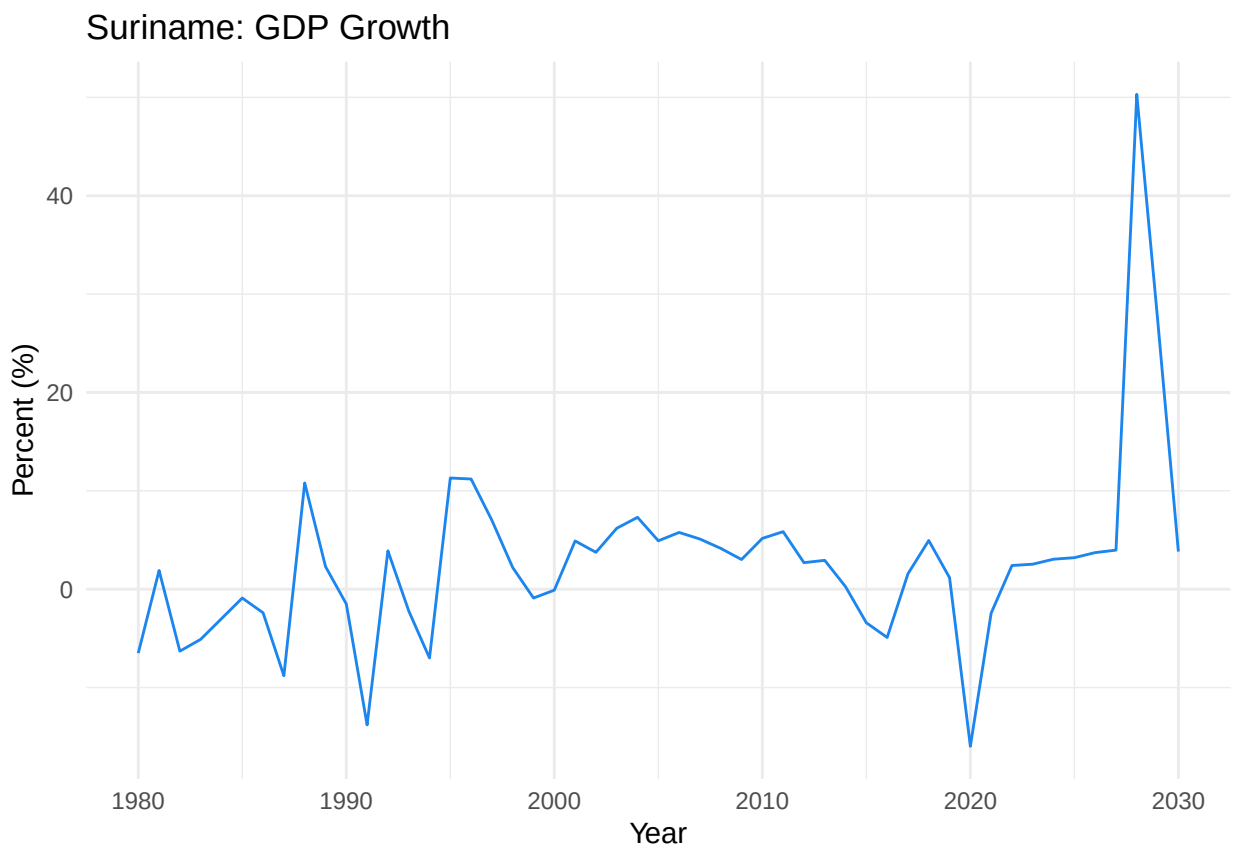
B.1 - Focus on Suriname trends over time

These graphs show the inflation and GDP growth (percentage change) over time for Suriname.

```r
# Inflation plot
p1 <- sur %>%
  filter(subject_descriptor %in% "Inflation, average consumer prices") %>%
  ggplot(aes(year, inflation)) +
  geom_line(color = "#EE2C2C") +
  labs(title = "Suriname: Inflation",
       y = "Percent (%)", x = "Year") +
  theme_minimal()
p1
```




```r
# GDP growth plot
p2 <- sur %>%
  filter(subject_descriptor %in% "Gross domestic product, constant prices") %>%
  ggplot(aes(year, gdp_growth)) +
  geom_line(color = "#1C86EE") +
  labs(title = "Suriname: GDP Growth",
       y = "Percent (%)", x = "Year") +
  theme_minimal()
p2
```



B.1.1 - PART 1: Suriname macroeconomics - GDP Growth and Inflation

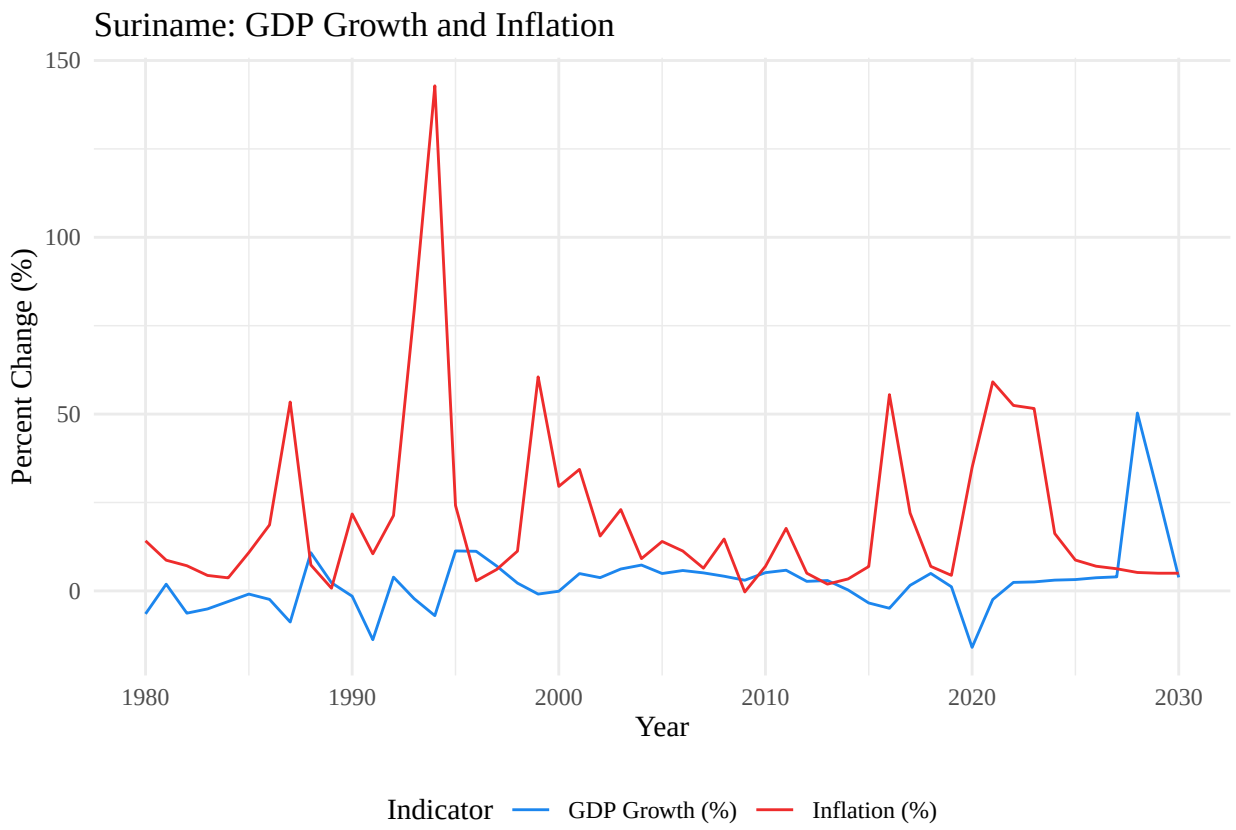
Suriname's GDP Growth and Inflation shown in one graph.

```
# PART 1: GDP Growth and Inflation
# Define indicators to plot
macro_indicators <- c("Inflation, average consumer prices",
                      "Gross domestic product, constant prices")


# Prepare wide-format data for plotting
df_macro <- sur %>%
  filter(subject_descriptor %in% macro_indicators) %>%
  mutate(
    variable = case_when(
      subject_descriptor == "Gross domestic product, constant prices" ~ "gdp_growth",
      subject_descriptor == "Inflation, average consumer prices" ~ "inflation"
    ),
    value = coalesce(gdp_growth, inflation)
  ) %>%
  select(year, variable, value) %>%
  pivot_wider(
    names_from = variable,
    values_from = value
  )
```

```
df_macro
```

```
## # A tibble: 51 x 3
##     year gdp_growth inflation
##    <int>      <dbl>     <dbl>
##  1  1980       -6.5    14.2
##  2  1981        1.9     8.68
##  3  1982       -6.3     7.12
##  4  1983       -5.1     4.37
##  5  1984       -3       3.69
##  6  1985       -0.9    10.9
##  7  1986       -2.4    18.7
##  8  1987       -8.8    53.4
##  9  1988       10.8     7.34
## 10  1989        2.3     0.758
## # i 41 more rows
```

```
# Plot GDP growth and inflation
p_sur_gdp_infl <- ggplot(df_macro, aes(x = year)) +
  geom_line(aes(y = gdp_growth, color = "GDP Growth (%)")) +
  geom_line(aes(y = inflation, color = "Inflation (%)")) +
  labs(
    title = "Suriname: GDP Growth and Inflation",
    x = "Year", y = "Percent Change (%)",
    color = "Indicator"
  ) +
  scale_color_manual(values = c("GDP Growth (%)" = "#1C86EE", "Inflation (%)" = "#EE2C2C")) +
  theme_minimal() +
  theme(legend.position = "bottom", text = element_text(family = "serif"))  # legend at bottom

p_sur_gdp_infl
```



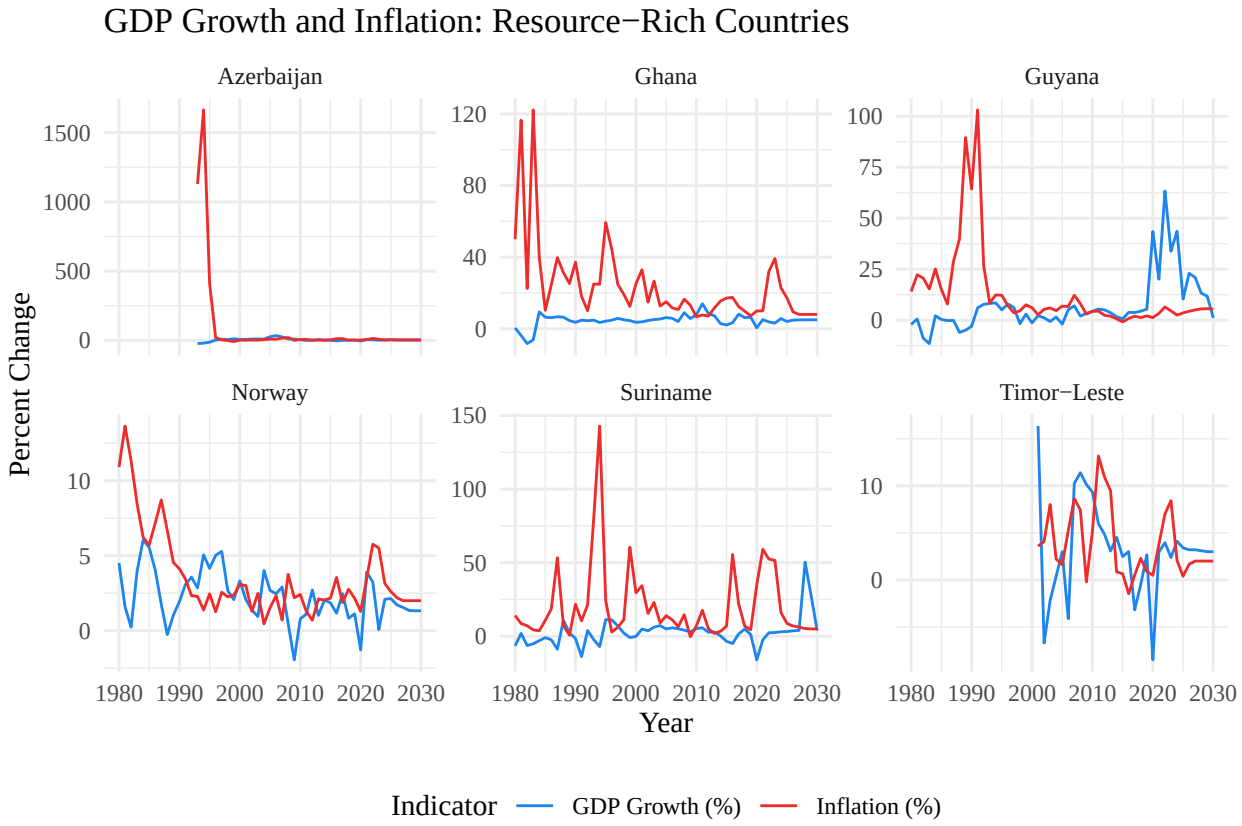
B.1.2 - Benchmark all countries macroeconomics - GDP Growth and Inflation

In this section, Suriname is being compared to other countries of interest.

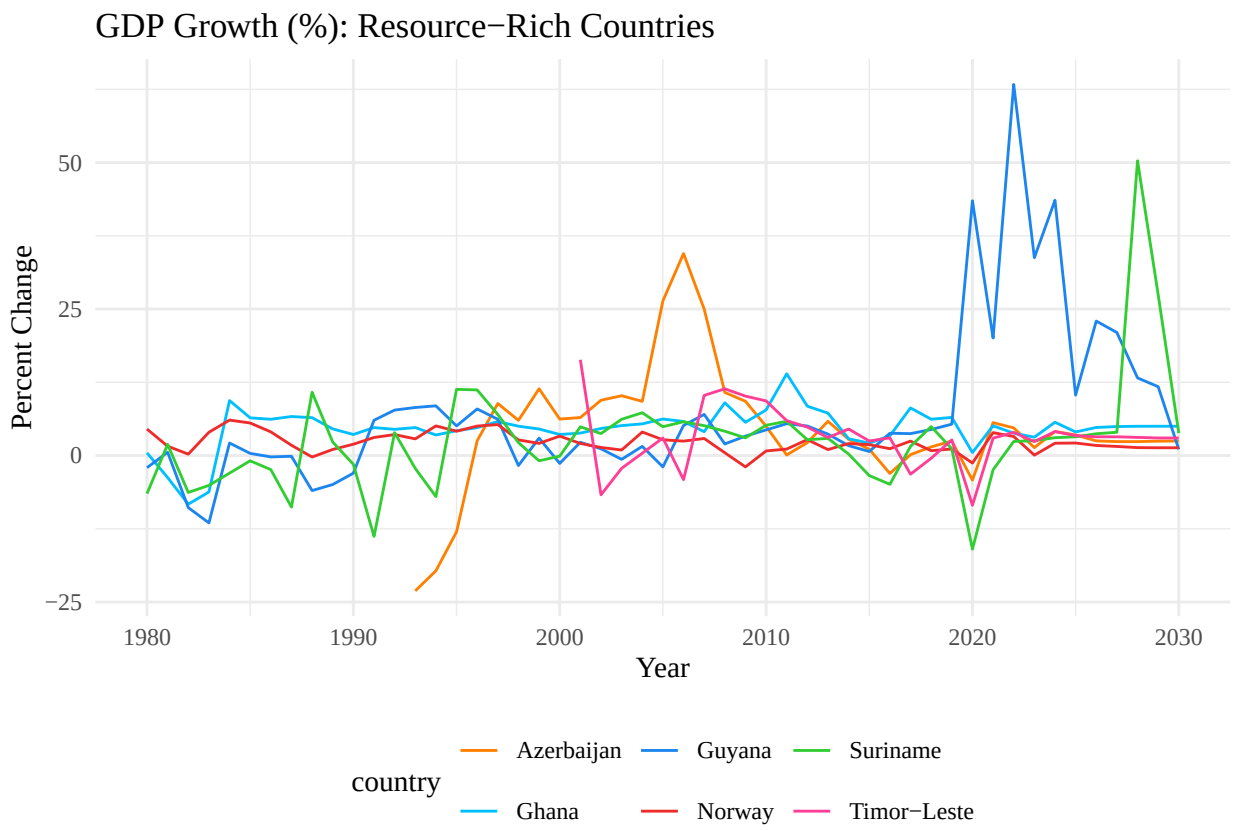
```
peer_countries <- c("Suriname", "Norway", "Timor-Leste", "Ghana", "Guyana", "Azerbaijan")

# Select and reshape data wide format
df_macro_peers <- weo_core %>%
  filter(country %in% peer_countries,
         subject_descriptor %in% c("Gross domestic product, constant prices",
                                   "Inflation, average consumer prices")) %>%
  mutate(
    variable = case_when(
      subject_descriptor == "Gross domestic product, constant prices" ~ "gdp_growth",
      subject_descriptor == "Inflation, average consumer prices" ~ "inflation"
    ),
    value = coalesce(gdp_growth, inflation)
  ) %>%
  select(country, year, variable, value) %>%
  pivot_wider(
    names_from = variable,
    values_from = value
  )

df_macro_peers
```

```
## # A tibble: 306 x 4
##    country     year gdp_growth inflation
##    <chr>      <int>      <dbl>     <dbl>
##  1 Azerbaijan  1980         NA        NA
##  2 Azerbaijan  1981         NA        NA
##  3 Azerbaijan  1982         NA        NA
##  4 Azerbaijan  1983         NA        NA
##  5 Azerbaijan  1984         NA        NA
##  6 Azerbaijan  1985         NA        NA
##  7 Azerbaijan  1986         NA        NA
##  8 Azerbaijan  1987         NA        NA
##  9 Azerbaijan  1988         NA        NA
## 10 Azerbaijan  1989         NA        NA
## # i 296 more rows
```

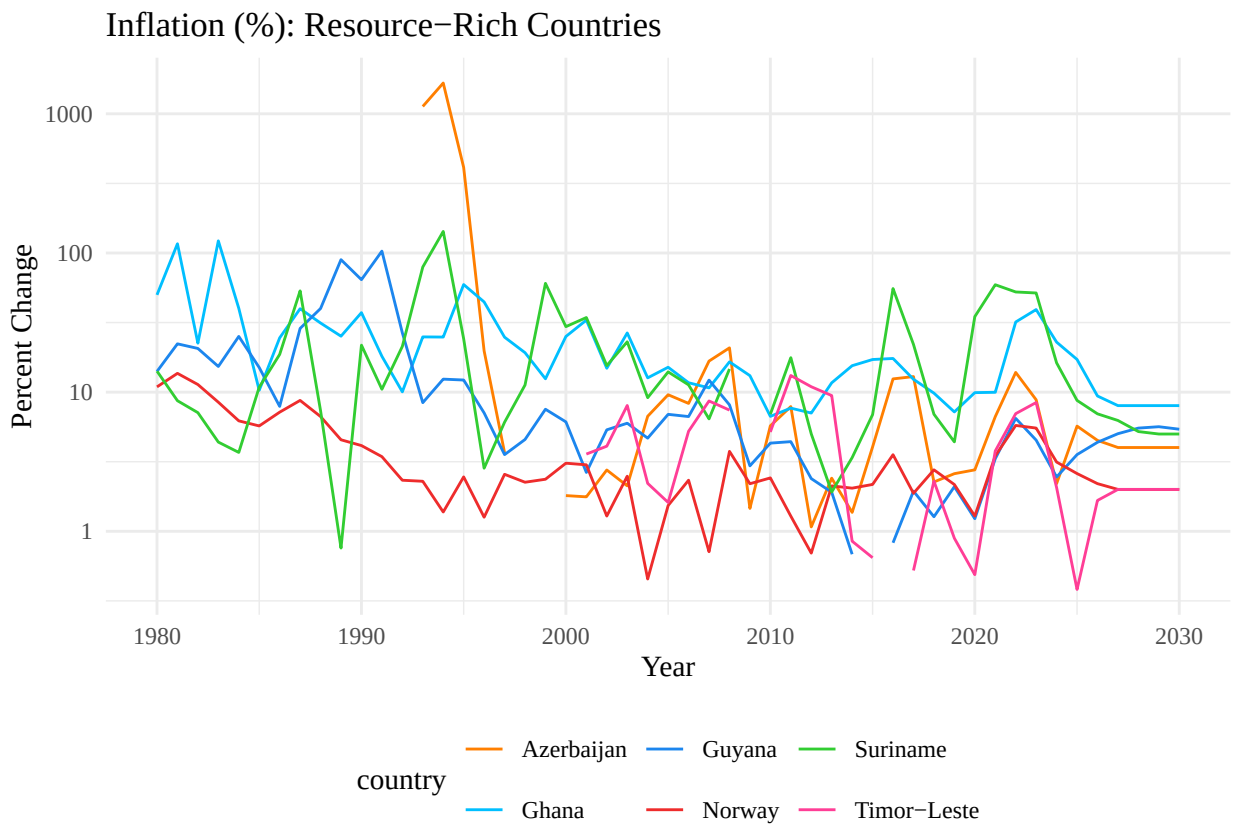
```r
# All in separate graphs (faceted)
p_all_gdp_infl <-ggplot(df_macro_peers, aes(x = year)) +
  geom_line(aes(y = gdp_growth, color = "GDP Growth (%)")) +
  geom_line(aes(y = inflation, color = "Inflation (%)")) +
  facet_wrap(~ country, scales = "free_y") +
  labs(
    title = "GDP Growth and Inflation: Resource-Rich Countries",
    x = "Year", y = "Percent Change",
    color = "Indicator"
  ) +
  scale_color_manual(values = c("GDP Growth (%)" = "#1C86EE", "Inflation (%)" = "#EE2C2C")) +
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))
p_all_gdp_infl
```




```
# All in one graph - GDP Growth only
df_gdp_growth <- weo_core %>%
  filter(country %in% peer_countries,
         subject_descriptor == "Gross domestic product, constant prices") %>%
  mutate(gdp_growth = gdp_growth) %>%
  select(country, year, gdp_growth)

country_colors <- c(
  "Suriname" = "#32CD32",
  "Guyana" = "#1C86EE",
  "Timor-Leste" = "#FF3E96",
  "Azerbaijan" = "#FF7F00",
  "Norway" = "#EE2C2C",
  "Ghana"= "#00BFFF"
)

p_all_gdp <- ggplot(df_gdp_growth, aes(x = year, y = gdp_growth, color = country)) +
  geom_line() +
  scale_color_manual(values = country_colors) +
  labs(
    title = "GDP Growth (%): Resource-Rich Countries",
    x = "Year", y = "Percent Change"
  ) +
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))
p_all_gdp
```




```
# All in one graph - Inflation only
df_inflation <- weo_core %>%
  filter(country %in% peer_countries,
         subject_descriptor == "Inflation, average consumer prices") %>%
  mutate(inflation = inflation) %>%
  select(country, year, inflation)

p_all_infl <- ggplot(df_inflation, aes(x = year, y = inflation, color = country)) +
  geom_line() +
  scale_color_manual(values = country_colors)+
  scale_y_log10()+
  labs(
    title = "Inflation (%): Resource-Rich Countries",
    x = "Year", y = "Percent Change"
  ) +
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))
p_all_infl
```



B.2 - PART 2: Suriname Fiscal - Revenue, Spending, Debt (% of GDP)

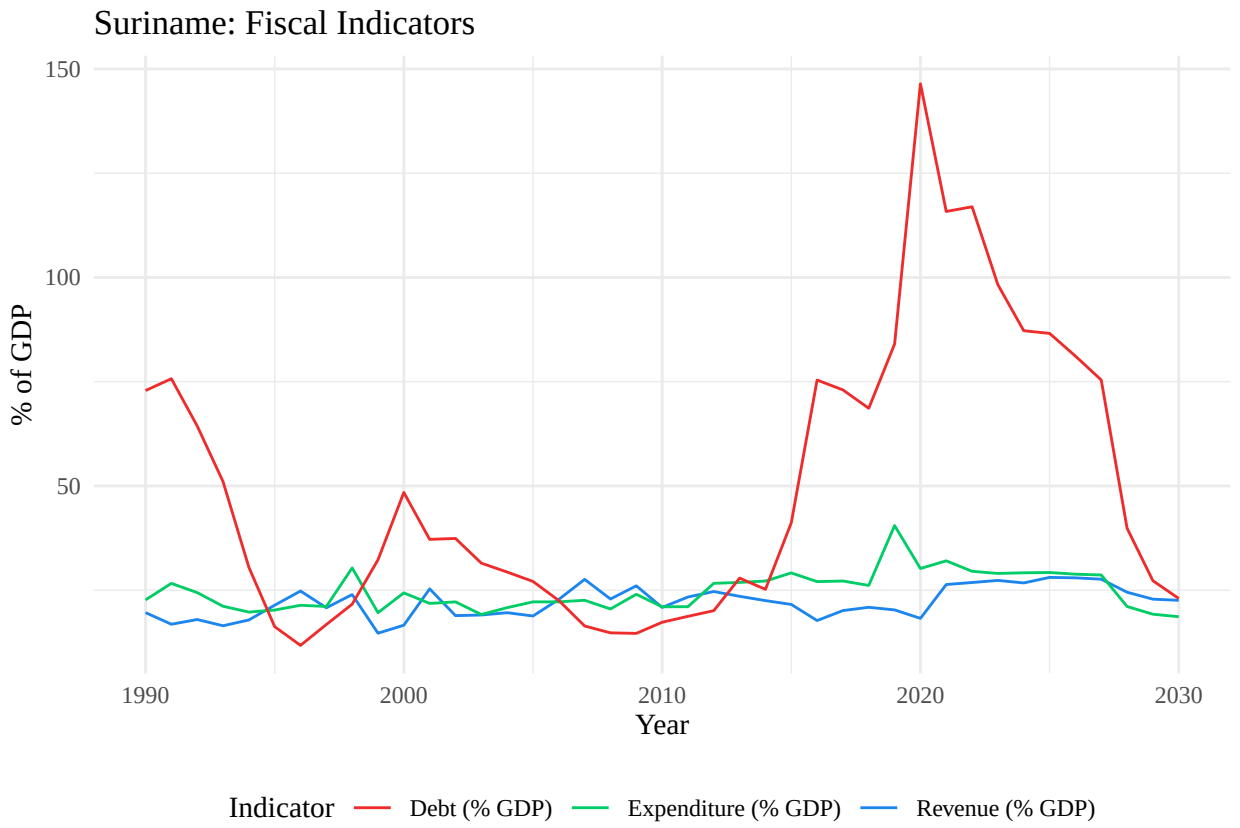
This section gathers the fiscal indicators of interest: government revenue, total expenditure and gross debt then plot's them.

```
# PART 2: Fiscal Indicators (% of GDP)
# Define fiscal indicators
fiscal_indicators <- c("General government revenue",
                       "General government total expenditure",
                       "General government gross debt")

# Prepare wide-format data
df_fiscal <- sur %>%
  filter(subject_descriptor %in% fiscal_indicators) %>%
  mutate(
    variable = case_when(
      subject_descriptor == "General government revenue" ~ "gov_revenue_gdp",
      subject_descriptor == "General government total expenditure" ~ "gov_expenditure_gdp",
      subject_descriptor == "General government gross debt" ~ "gov_debt_gdp"
    ),
    value = coalesce(gov_revenue_gdp, gov_expenditure_gdp, gov_debt_gdp)
  ) %>%
  select(year, variable, value) %>%
  pivot_wider(
    names_from = variable,
```

```
    values_from = value
  )
df_fiscal
```

```
## # A tibble: 51 x 4
##     year gov_revenue_gdp gov_expenditure_gdp gov_debt_gdp
##    <int>           <dbl>               <dbl>        <dbl>
##  1  1980              NA                  NA           NA
##  2  1981              NA                  NA           NA
##  3  1982              NA                  NA           NA
##  4  1983              NA                  NA           NA
##  5  1984              NA                  NA           NA
##  6  1985              NA                  NA           NA
##  7  1986              NA                  NA           NA
##  8  1987              NA                  NA           NA
##  9  1988              NA                  NA           NA
## 10  1989              NA                  NA           NA
## # i 41 more rows
```

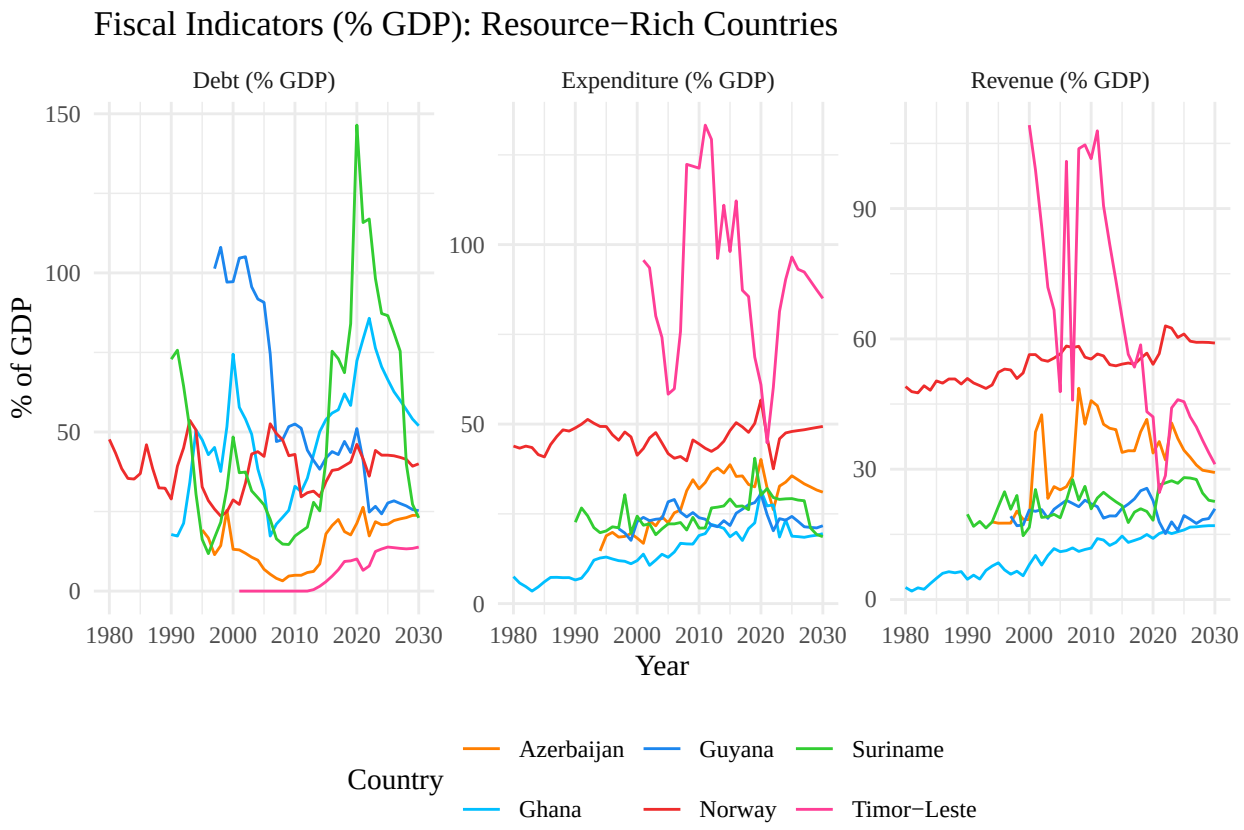
```
# Plot Fiscal Indicators
p_sur_fisc <- df_fiscal %>%
  drop_na() %>%
  ggplot(aes(x = year)) +
  geom_line(aes(y = gov_revenue_gdp, color = "Revenue (% GDP)")) +
  geom_line(aes(y = gov_expenditure_gdp, color = "Expenditure (% GDP)")) +
  geom_line(aes(y = gov_debt_gdp, color = "Debt (% GDP)")) +
  labs(
    title = "Suriname: Fiscal Indicators",
    x = "Year", y = "% of GDP",
    color = "Indicator"
  ) +
  scale_color_manual(values = c("Revenue (% GDP)" = "#1C86EE", "Expenditure (% GDP)" = "#00CD66","Debt
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))

p_sur_fisc
```



B.2.1 - Benchmark all countries fiscal - Revenue, Spending, Debt (% of GDP)

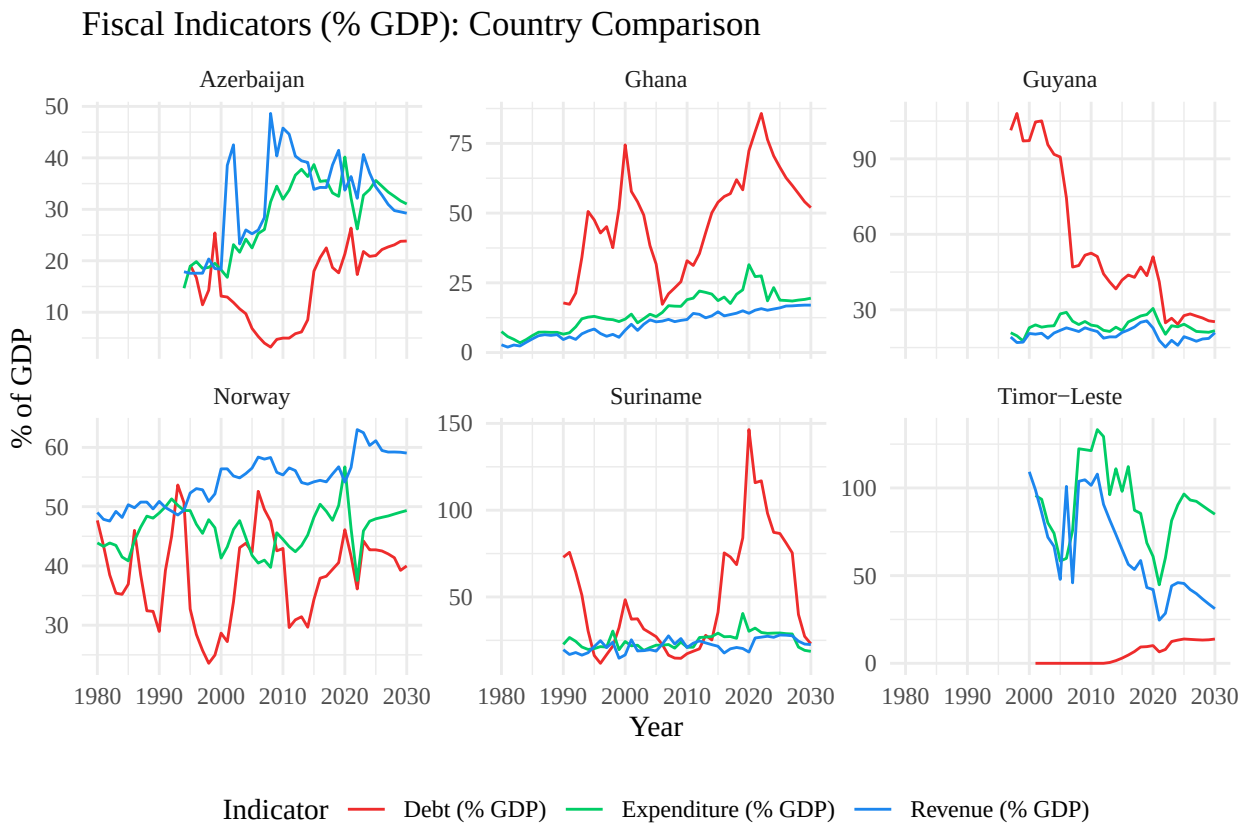
```
# Define fiscal indicators of interest
fiscal_indicators <- c("General government revenue",
                       "General government total expenditure",
                       "General government gross debt")

# Prepare dataset
df_fiscal_all <- weo_core %>%
  filter(country %in% peer_countries,
         subject_descriptor %in% fiscal_indicators) %>%
  mutate(
    indicator = case_when(
      subject_descriptor == "General government revenue" ~ "Revenue (% GDP)",
      subject_descriptor == "General government total expenditure" ~ "Expenditure (% GDP)",
      subject_descriptor == "General government gross debt" ~ "Debt (% GDP)"
    ),
    value = coalesce(gov_revenue_gdp, gov_expenditure_gdp, gov_debt_gdp)
  ) %>%
  select(country, year, indicator, value)

# Plot
p_all_fisc <- ggplot(df_fiscal_all, aes(x = year, y = value, color = country)) +
  geom_line() +
```

```
  facet_wrap(~ indicator, scales = "free_y") +
  scale_color_manual(values = country_colors)+
  labs(
    title = "Fiscal Indicators (% GDP): Resource-Rich Countries",
    x = "Year", y = "% of GDP",
    color = "Country"
  ) +
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))
p_all_fisc
```




```
# Faceted by country
# Prepare data (same as before)
df_fiscal_all <- weo_core %>%
  filter(country %in% peer_countries,
         subject_descriptor %in% fiscal_indicators) %>%
  mutate(
    indicator = case_when(
      subject_descriptor == "General government revenue" ~ "Revenue (% GDP)",
      subject_descriptor == "General government total expenditure" ~ "Expenditure (% GDP)",
      subject_descriptor == "General government gross debt" ~ "Debt (% GDP)"
    ),
    value = coalesce(gov_revenue_gdp, gov_expenditure_gdp, gov_debt_gdp)
  ) %>%
  select(country, year, indicator, value)
```

```r
# Plot with facets by country
p_all_fisc_2 <- ggplot(df_fiscal_all, aes(x = year, y = value, color = indicator)) +
  geom_line() +
  facet_wrap(~ country, scales = "free_y") +
  labs(
    title = "Fiscal Indicators (% GDP): Country Comparison",
    x = "Year", y = "% of GDP",
    color = "Indicator"
  ) +
  scale_color_manual(values = c("Revenue (% GDP)" = "#1C86EE", "Expenditure (% GDP)" = "#00CD66","Debt
  theme_minimal()+
  theme(legend.position = "bottom", text = element_text(family = "serif"))


p_all_fisc_2
```



PHASE C - Descriptive and Comparative Analysis

This phase moves beyond descriptive plots and starts analysing patterns, thus transitioning from descriptive data exploration to structured comparative analysis. The guiding inquiry is:

What can Suriname learn from other resource-rich economies about managing oil revenues for sustainable growth?

The cleaned IMF data will be used to build a combined macro–fiscal panel data set (all relevant countries and indicators in tidy format). That will allow us to run regressions and deeper comparisons.

```
#We want one tidy panel dataset with all countries,
#all years, and all key indicators in columns.

# Step 0. Pivot wide IMF data (with year columns) into tidy long format first
weo_long <- weo %>%
  clean_names() %>%
  mutate(across(matches("^x\\d{4}"), as.numeric)) %>%
  pivot_longer(
    cols = matches("^x\\d{4}"),
    names_to = "year",
    values_to = "value"
  ) %>%
  mutate(year = as.integer(sub("x", "", year)))


library(dplyr)
library(tidyr)
library(janitor)

# Step 1. Select indicators of interest
key_indicators <- c(
  "Gross domestic product, constant prices",     # GDP growth (Percent change)
  "Inflation, average consumer prices",          # Inflation (Percent change)
  "General government revenue",                  # Gov revenue (% GDP)
  "General government total expenditure",        # Gov expenditure (% GDP)
  "General government gross debt",               # Gov debt (% GDP)
  "Current account balance"                      # Current account (% GDP)
)


# Step 2. Filter for countries + indicators
panel_raw <- weo_long %>%
  filter(country %in% peer_countries,
         subject_descriptor %in% key_indicators)

# Step 3. Map to clean variable names
panel_tidy <- panel_raw %>%
  mutate(
    variable = case_when(
      subject_descriptor == "Gross domestic product, constant prices" ~ "gdp_growth",
      subject_descriptor == "Inflation, average consumer prices" ~ "inflation",
      subject_descriptor == "General government revenue" ~ "gov_revenue_gdp",
      subject_descriptor == "General government total expenditure" ~ "gov_expenditure_gdp",
      subject_descriptor == "General government gross debt" ~ "gov_debt_gdp",
      subject_descriptor == "Current account balance" ~ "current_account_gdp"
    )
  ) %>%
  select(country, year, variable, value)

# Step 4. Clean numeric + collapse duplicates
panel <- panel_tidy %>%
```

```
  group_by(country, year, variable) %>%
  summarise(value = mean(as.numeric(value), na.rm = TRUE), .groups = "drop") %>%
  pivot_wider(names_from = variable, values_from = value)

#This panel object is the clean country-year data set with proper numeric values.
#From here, we can start exploring trends, correlations, and regressions.

panel
```

```
## # A tibble: 306 x 8
##    country  year current_account_gdp gdp_growth gov_debt_gdp gov_expenditure_gdp
##    <chr>   <int>               <dbl>      <dbl>        <dbl>                <dbl>
##  1 Azerba~  1980                 NaN        NaN          NaN                  NaN
##  2 Azerba~  1981                 NaN        NaN          NaN                  NaN
##  3 Azerba~  1982                 NaN        NaN          NaN                  NaN
##  4 Azerba~  1983                 NaN        NaN          NaN                  NaN
##  5 Azerba~  1984                 NaN        NaN          NaN                  NaN
##  6 Azerba~  1985                 NaN        NaN          NaN                  NaN
##  7 Azerba~  1986                 NaN        NaN          NaN                  NaN
##  8 Azerba~  1987                 NaN        NaN          NaN                  NaN
##  9 Azerba~  1988                 NaN        NaN          NaN                  NaN
## 10 Azerba~  1989                 NaN        NaN          NaN                  NaN
## # i 296 more rows
## # i 2 more variables: gov_revenue_gdp <dbl>, inflation <dbl>
```

C.1 - Descriptive Exploration (vizual atls)

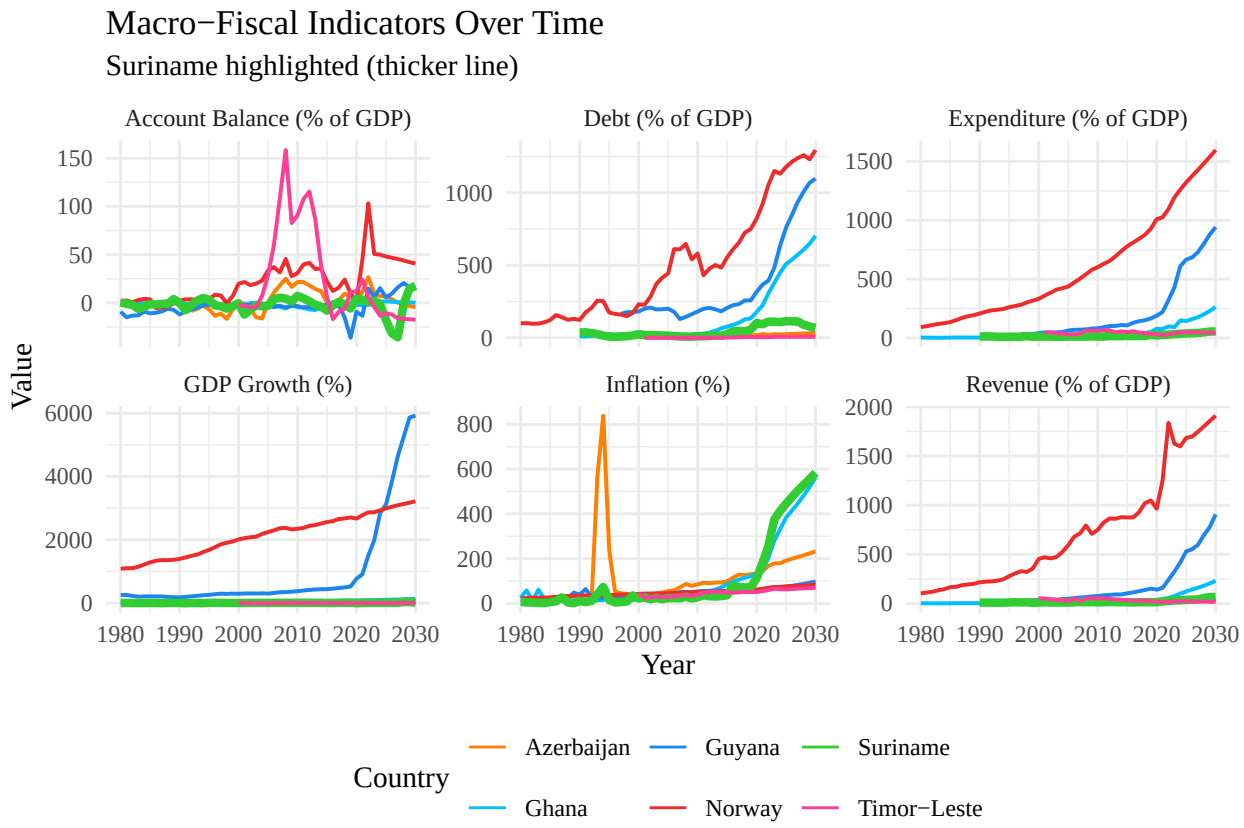
A combination of macroeconomic and fiscal indicators shown together.

```
library(dplyr)
library(ggplot2)

indicator_labels <- c(
  current_account_gdp = "Account Balance (% of GDP)",
  gdp_growth = "GDP Growth (%)",
  inflation = "Inflation (%)",
  gov_revenue_gdp = "Revenue (% of GDP)",
  gov_expenditure_gdp = "Expenditure (% of GDP)",
  gov_debt_gdp = "Debt (% of GDP)",
  fiscal_balance_gdp = "Fiscal Balance (% of GDP)"
)

panel_long <- panel %>%
  mutate(across(-c(country, year), as.character)) %>%
  pivot_longer(
    cols = -c(country, year),
    names_to = "indicator",
    values_to = "value"
  ) %>%
  mutate(
    value = as.numeric(value),
    indicator = dplyr::recode(indicator, !!!indicator_labels)
```

```
  )

panel_long
```

```
## # A tibble: 1,836 x 4
##    country     year indicator                  value
##    <chr>      <int> <chr>                      <dbl>
##  1 Azerbaijan  1980 Account Balance (% of GDP)   NaN
##  2 Azerbaijan  1980 GDP Growth (%)               NaN
##  3 Azerbaijan  1980 Debt (% of GDP)              NaN
##  4 Azerbaijan  1980 Expenditure (% of GDP)       NaN
##  5 Azerbaijan  1980 Revenue (% of GDP)           NaN
##  6 Azerbaijan  1980 Inflation (%)                NaN
##  7 Azerbaijan  1981 Account Balance (% of GDP)   NaN
##  8 Azerbaijan  1981 GDP Growth (%)               NaN
##  9 Azerbaijan  1981 Debt (% of GDP)              NaN
## 10 Azerbaijan  1981 Expenditure (% of GDP)       NaN
## # i 1,826 more rows
```

```
# Define custom colors for each country
country_colors <- c(
  "Suriname" = "#32CD32",
  "Guyana" = "#1C86EE",
  "Timor-Leste" = "#FF3E96",
  "Azerbaijan" = "#FF7F00",
  "Norway" = "#EE2C2C",
  "Ghana"= "#00BFFF"
)

p_macro_fisc <- ggplot(panel_long, aes(x = year, y = value, group = country)) +
  geom_line(aes(color = country,
                size = (country == "Suriname"))) +
  scale_size_manual(values = c("TRUE" = 1.5, "FALSE" = 0.7), guide = "none") +
  scale_color_manual(values = country_colors) +  # assign custom colors
  facet_wrap(~ indicator, scales = "free_y") +
  labs(
    title = "Macro-Fiscal Indicators Over Time",
    subtitle = "Suriname highlighted (thicker line)",
    x = "Year", y = "Value",
    color = "Country"
  ) +
  theme_minimal() +
  theme(legend.position = "bottom", text = element_text(family = "serif"))

p_macro_fisc
```



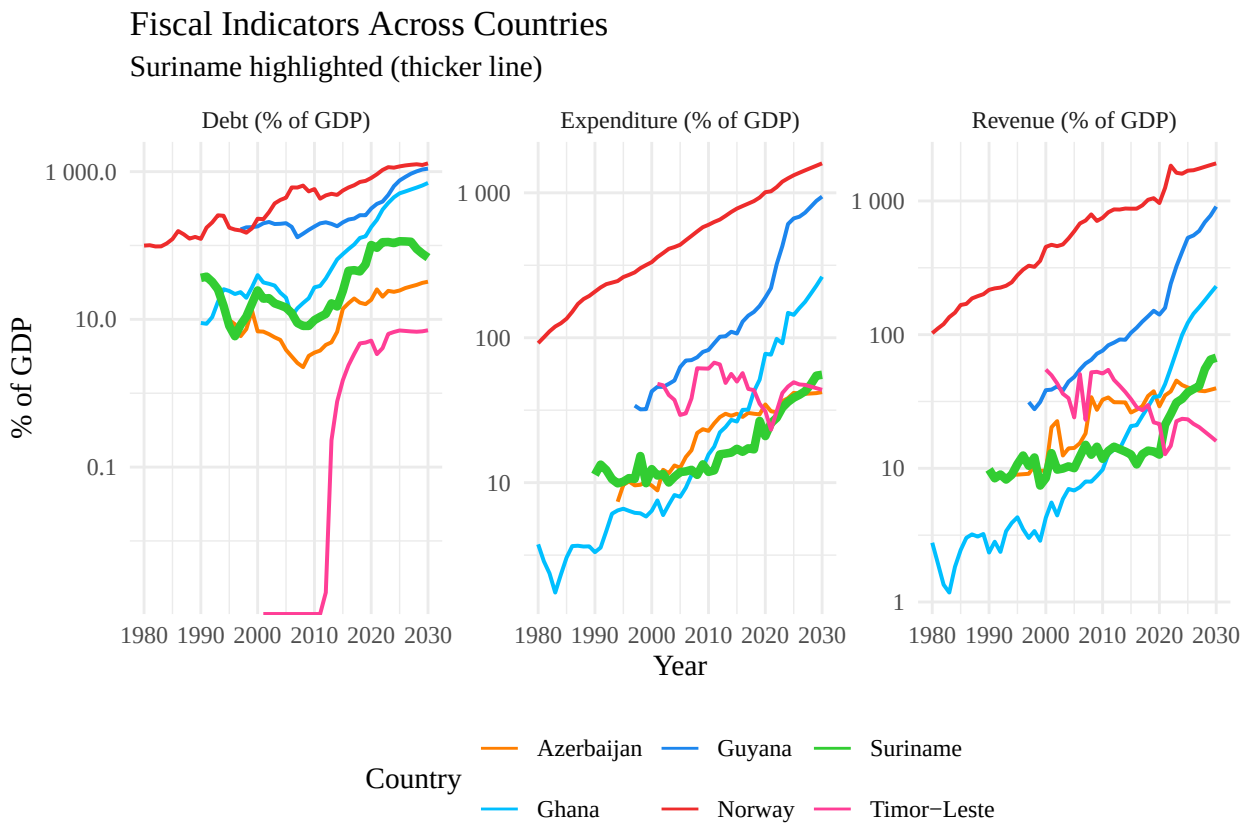
Here are the same fiscal indicator plots on a logarithmic scale directly compare Suriname's fiscal performance with peers.

```
# 1. Long format and relab
df_fiscal <- panel_long |>
  filter(indicator %in% c("Revenue (% of GDP)",
                          "Expenditure (% of GDP)",
                          "Debt (% of GDP)")) |>
  mutate(
    year = as.numeric(year)
  )

df_fiscal
```

```
## # A tibble: 918 x 4
##    country     year indicator              value
##    <chr>      <dbl> <chr>                  <dbl>
##  1 Azerbaijan  1980 Debt (% of GDP)          NaN
##  2 Azerbaijan  1980 Expenditure (% of GDP)   NaN
##  3 Azerbaijan  1980 Revenue (% of GDP)       NaN
##  4 Azerbaijan  1981 Debt (% of GDP)          NaN
##  5 Azerbaijan  1981 Expenditure (% of GDP)   NaN
##  6 Azerbaijan  1981 Revenue (% of GDP)       NaN
##  7 Azerbaijan  1982 Debt (% of GDP)          NaN
##  8 Azerbaijan  1982 Expenditure (% of GDP)   NaN
##  9 Azerbaijan  1982 Revenue (% of GDP)       NaN
```

```
## 10 Azerbaijan  1983 Debt (% of GDP)          NaN
## # i 908 more rows
```

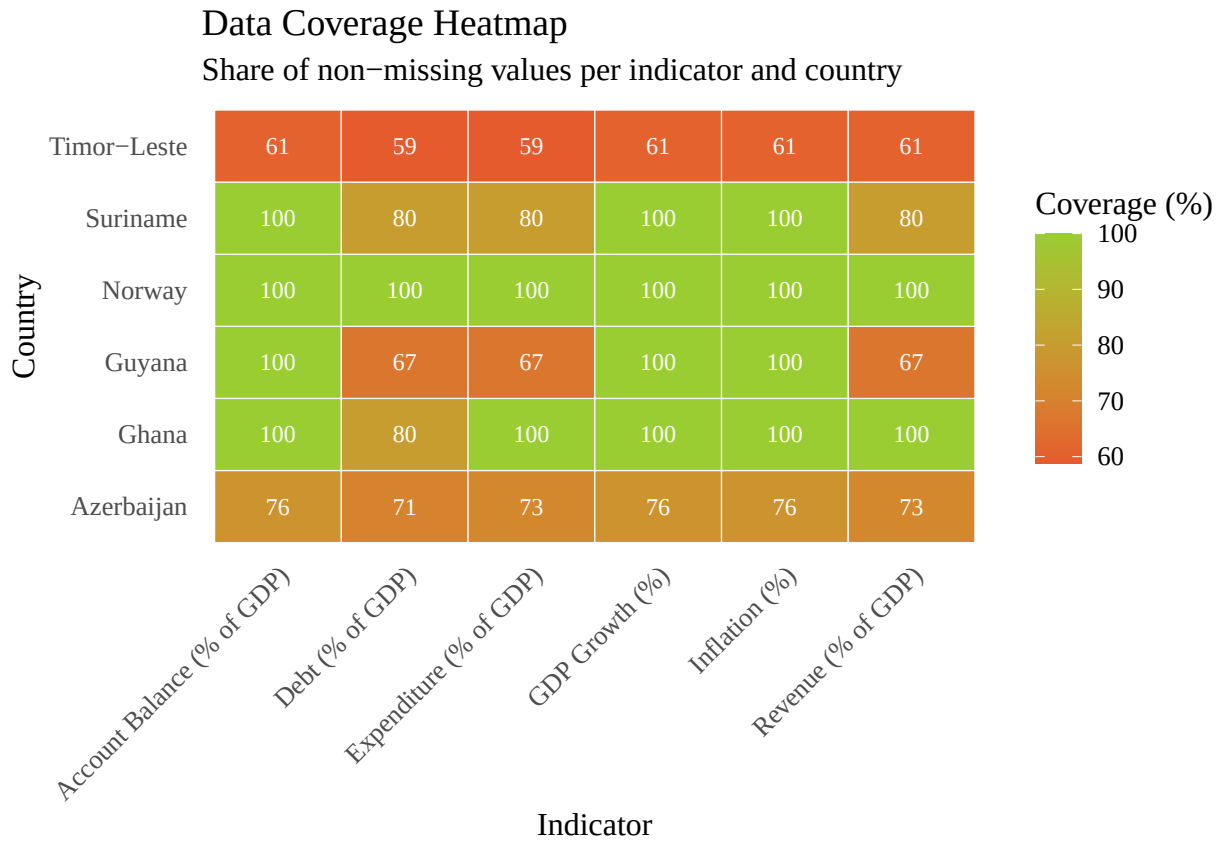
```
# 2. Plot
p_fisc <- ggplot(df_fiscal, aes(x = year, y = value, group = country)) +
  geom_line(aes(color = country, size = (country == "Suriname"))) +
  scale_size_manual(values = c("TRUE" = 1.5, "FALSE" = 0.7), guide = "none") +
  scale_color_manual(values = country_colors) +  # assign custom colors
  scale_y_log10(labels = scales::label_number()) +
  facet_wrap(~ indicator, scales = "free_y") +
  labs(
    title = "Fiscal Indicators Across Countries",
    subtitle = "Suriname highlighted (thicker line)",
    x = "Year", y = "% of GDP",
    color = "Country"
  ) +
  theme_minimal() +
  theme(legend.position = "bottom", text = element_text(family = "serif"))

p_fisc
```



C.2 - Coverage Heatmap (data completeness)

For each indicator–country–year cell, check if the data is or is not available (NA).

```r
# 1. Pivot long
#panel_long

# 2. Coverage summary (non-NA percentage)
coverage <- panel_long %>%
  group_by(country, indicator) %>%
  summarise(
    coverage = mean(!is.na(value)) * 100,
    .groups = "drop"
  )

# 3. Plot Heat map
coverage |> ggplot(aes(indicator, country, fill = coverage))+
  geom_tile(color = "white") +
    geom_text(aes(label = ifelse(coverage >= 50, round(coverage, 0), "")), color = "white", size = 3)+
  scale_fill_gradient2(mid = "#EE2C2C", high = "#9ACD32", midpoint = 50,
                       name = "Coverage (%)") +
  labs(
    title = "Data Coverage Heatmap",
    subtitle = "Share of non-missing values per indicator and country",
    x = "Indicator", y = "Country"
  ) +
  theme_minimal(base_size = 12, base_family = "serif") +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    panel.grid = element_blank()
  )
```



C.3 - Stylized Facts

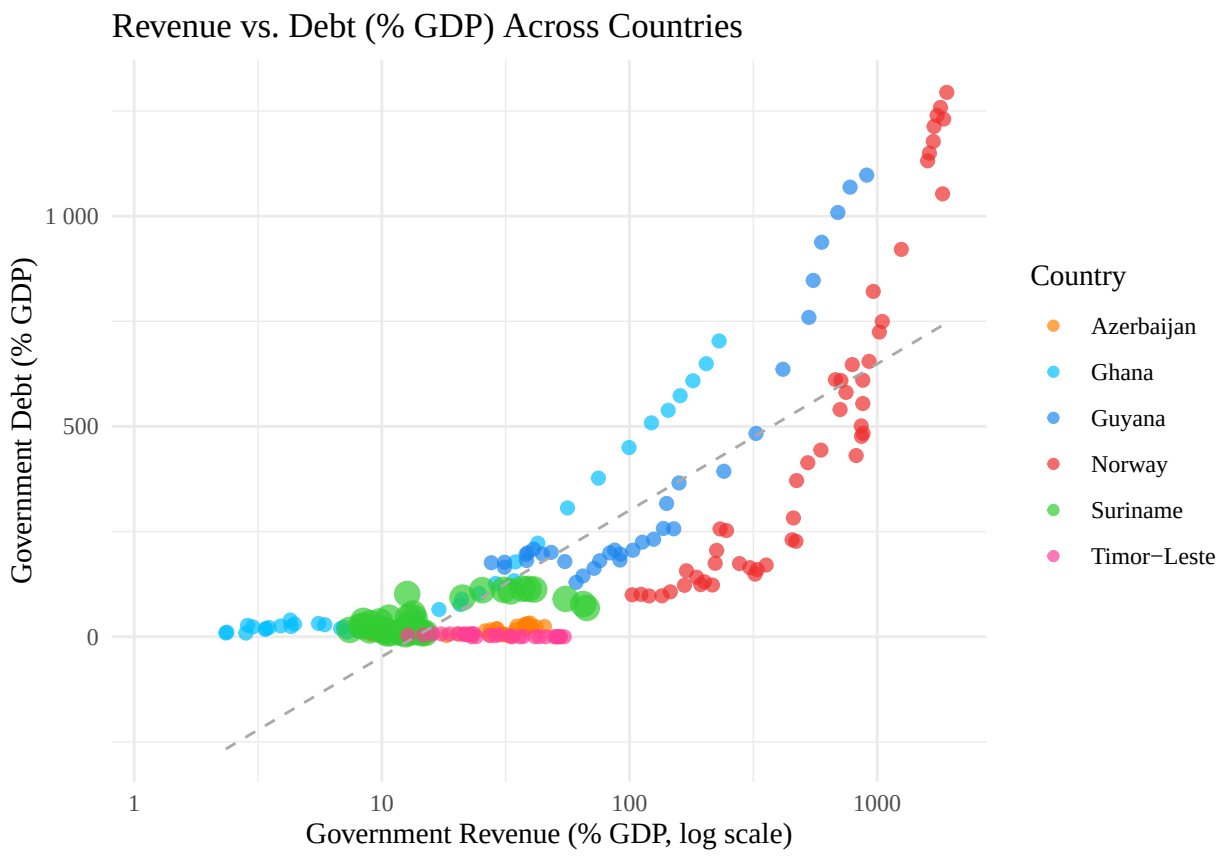
We move beyond line plots and start exploring relationships between variables. this will set us up for the econometric phase. First, a panel regression of fiscal sustainability (Revenue vs Debt (% GDP) is performed.

C.3.1 Revenue vs. Debt (% GDP)

First, a panel regression of Revenue vs Debt (% GDP) (fiscal sustainability) is performed to answer the question: what is the relationship between government revenue and government debt levels across countries?

```
## # A tibble: 306 x 4
##    country     year gov_revenue_gdp gov_debt_gdp
##    <chr>      <int>           <dbl>        <dbl>
##  1 Azerbaijan  1980             NaN          NaN
##  2 Azerbaijan  1981             NaN          NaN
##  3 Azerbaijan  1982             NaN          NaN
##  4 Azerbaijan  1983             NaN          NaN
##  5 Azerbaijan  1984             NaN          NaN
##  6 Azerbaijan  1985             NaN          NaN
##  7 Azerbaijan  1986             NaN          NaN
##  8 Azerbaijan  1987             NaN          NaN
##  9 Azerbaijan  1988             NaN          NaN
## 10 Azerbaijan  1989             NaN          NaN
## # i 296 more rows
```

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



C.3.2 Growth vs. Fiscal Balance (% GDP)

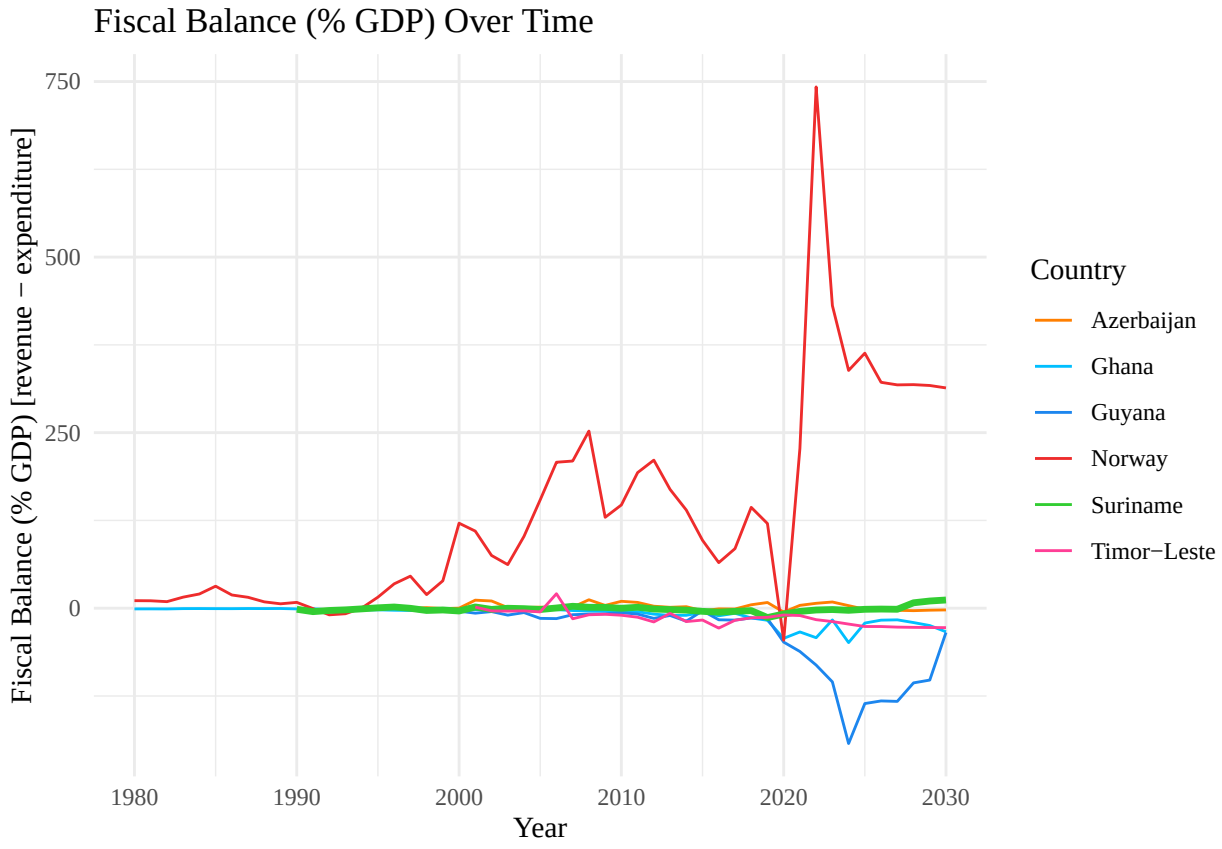
Second, fiscal Balance is analysed (fiscal stance vs. growth). To do this, first fiscal balanced is defined as the difference between government revenue and expenditure (% of GDP).

```
panel <- panel|> mutate(fiscal_balance_gdp = gov_revenue_gdp - gov_expenditure_gdp)
df_gdp_fiscal <- panel |>
  select(country, year, gdp_growth, fiscal_balance_gdp)

df_gdp_fiscal
```

```
## # A tibble: 306 x 4
##    country     year gdp_growth fiscal_balance_gdp
##    <chr>      <int>      <dbl>              <dbl>
##  1 Azerbaijan  1980        NaN                NaN
##  2 Azerbaijan  1981        NaN                NaN
##  3 Azerbaijan  1982        NaN                NaN
##  4 Azerbaijan  1983        NaN                NaN
##  5 Azerbaijan  1984        NaN                NaN
##  6 Azerbaijan  1985        NaN                NaN
##  7 Azerbaijan  1986        NaN                NaN
##  8 Azerbaijan  1987        NaN                NaN
```

```
##  9 Azerbaijan  1988        NaN                NaN
## 10 Azerbaijan  1989        NaN                NaN
## # i 296 more rows
```

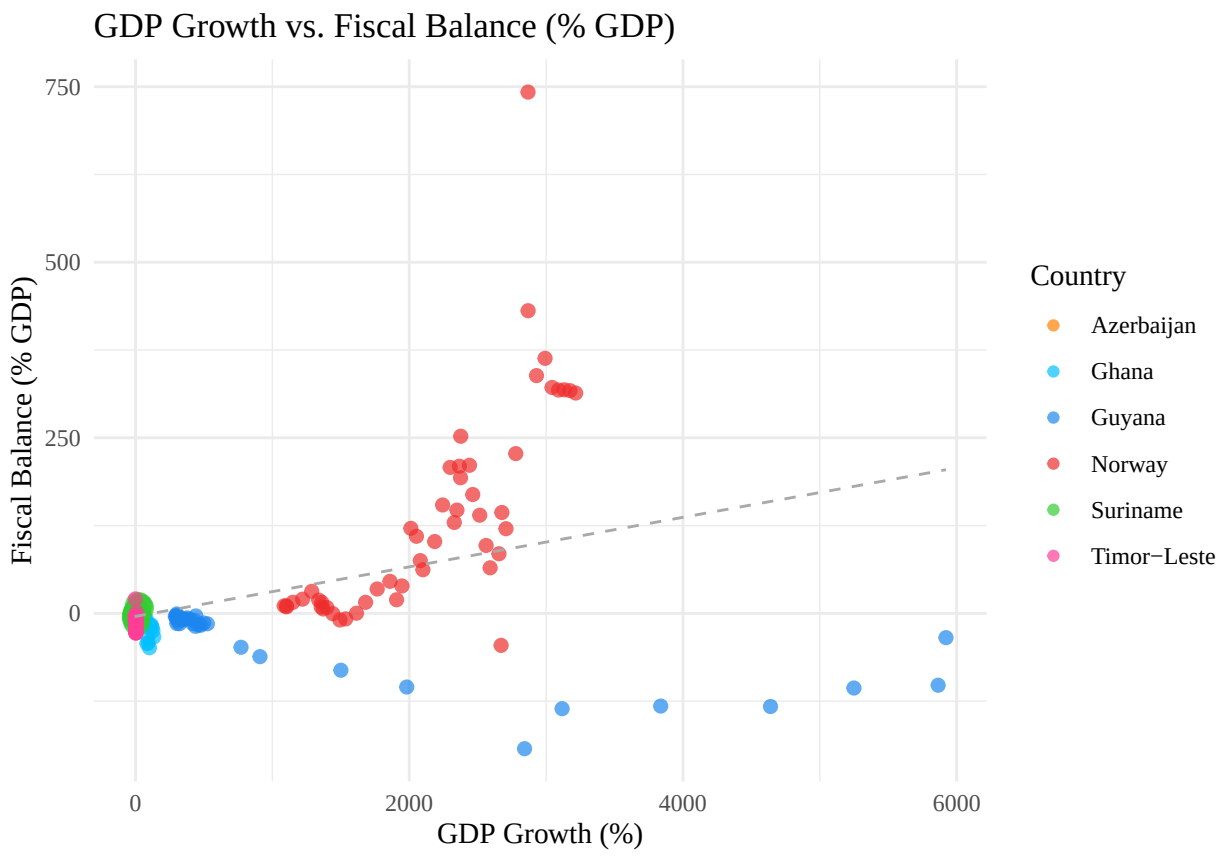
```r
# Time-Series Fiscal Balance
p_fiscal_balance <- df_gdp_fiscal %>%
  ggplot(aes(year,fiscal_balance_gdp, group = country)) +
  geom_line(aes(color = country, size = (country == "Suriname"))) +
  scale_color_manual(values = country_colors) +
  scale_size_manual(values = c("TRUE" = 1.2, "FALSE" = 0.5), guide = "none") +
  labs(
    title = "Fiscal Balance (% GDP) Over Time",
    x = "Year",
    y = "Fiscal Balance (% GDP) [revenue - expenditure]",
    color = "Country"
  ) +
  theme_minimal(base_family = "serif")

p_fiscal_balance
```




```r
# GDP Growth vs Fiscal Balance
p_growth_fiscal <- panel %>%
  ggplot(aes(x = gdp_growth, y = fiscal_balance_gdp)) +
  geom_point(aes(color = country, size = (country == "Suriname")), alpha = 0.7) +
  geom_smooth(method = "lm", se = FALSE, color = "darkgrey", linetype = "dashed", size = 0.5) +
```

```
  scale_color_manual(values = country_colors) +
  scale_size_manual(values = c("TRUE" = 4, "FALSE" = 2), guide = "none") +
  labs(
    title = "GDP Growth vs. Fiscal Balance (% GDP)",
    x = "GDP Growth (%)",
    y = "Fiscal Balance (% GDP)",
    color = "Country"
  ) +
  theme_minimal(base_family = "serif")

p_growth_fiscal
```

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

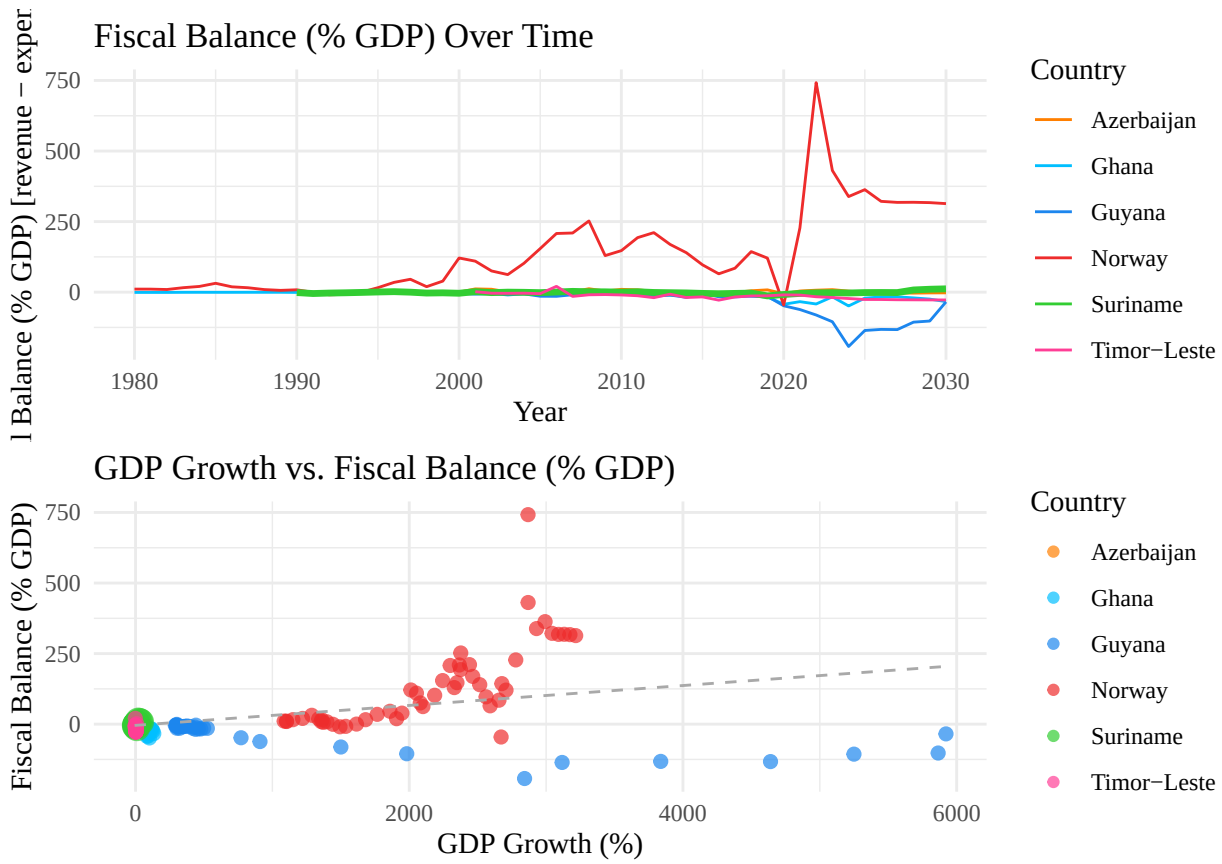



```
# Combine the graphs
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'
##
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
grid.arrange(p_fiscal_balance, p_growth_fiscal, ncol = 1)
```

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



C.4 - Foundations of Econometric Analysis

```
#Start with a panel regression of government debt (% GDP)
#on fiscal balance (% GDP) across countries.
#Using predominantly plm() instead of lm()

if (!requireNamespace("plm", quietly = TRUE)) install.packages("plm")
library(plm)
```

```
##
## Attaching package: 'plm'

## The following objects are masked from 'package:dplyr':
##
##     between, lag, lead
```

```r
# 1) Prepare regression data (explicitly drop NA)
df_reg <- panel %>%
  select(country, year, gov_debt_gdp, fiscal_balance_gdp) %>%
  filter(!is.na(gov_debt_gdp) & !is.na(fiscal_balance_gdp))

# 2) Panel fixed-effects regression (existing "global" test)
pdata <- pdata.frame(df_reg, index = c("country", "year"))
model_debt_fb <- plm(gov_debt_gdp ~ fiscal_balance_gdp, data = pdata, model = "within")
summary(model_debt_fb)   # use this for inference (FE slope is main object of interest)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = pdata,
##     model = "within")
##
## Unbalanced Panel: n = 6, T = 30-51, N = 233
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -406.853 -140.846  -15.331   21.761  803.316
##
## Coefficients:
##                    Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp  1.56849    0.18613  8.4269 4.167e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    12396000
## Residual Sum of Squares: 9432400
## R-Squared:      0.23909
## Adj. R-Squared: 0.21889
## F-statistic: 71.0132 on 1 and 226 DF, p-value: 4.1673e-15
```

```r
# 3) Pooled OLS (ordinary least squares) (for plotting a single "global" line)
model_pooled_lm <- lm(gov_debt_gdp ~ fiscal_balance_gdp, data = df_reg)
summary(model_pooled_lm)
```

```
##
## Call:
## lm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_reg)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -475.47 -145.82 -109.23   48.55 1092.94
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)        164.1746    16.7712   9.789   <2e-16 ***
## fiscal_balance_gdp   1.8381     0.1742  10.549   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

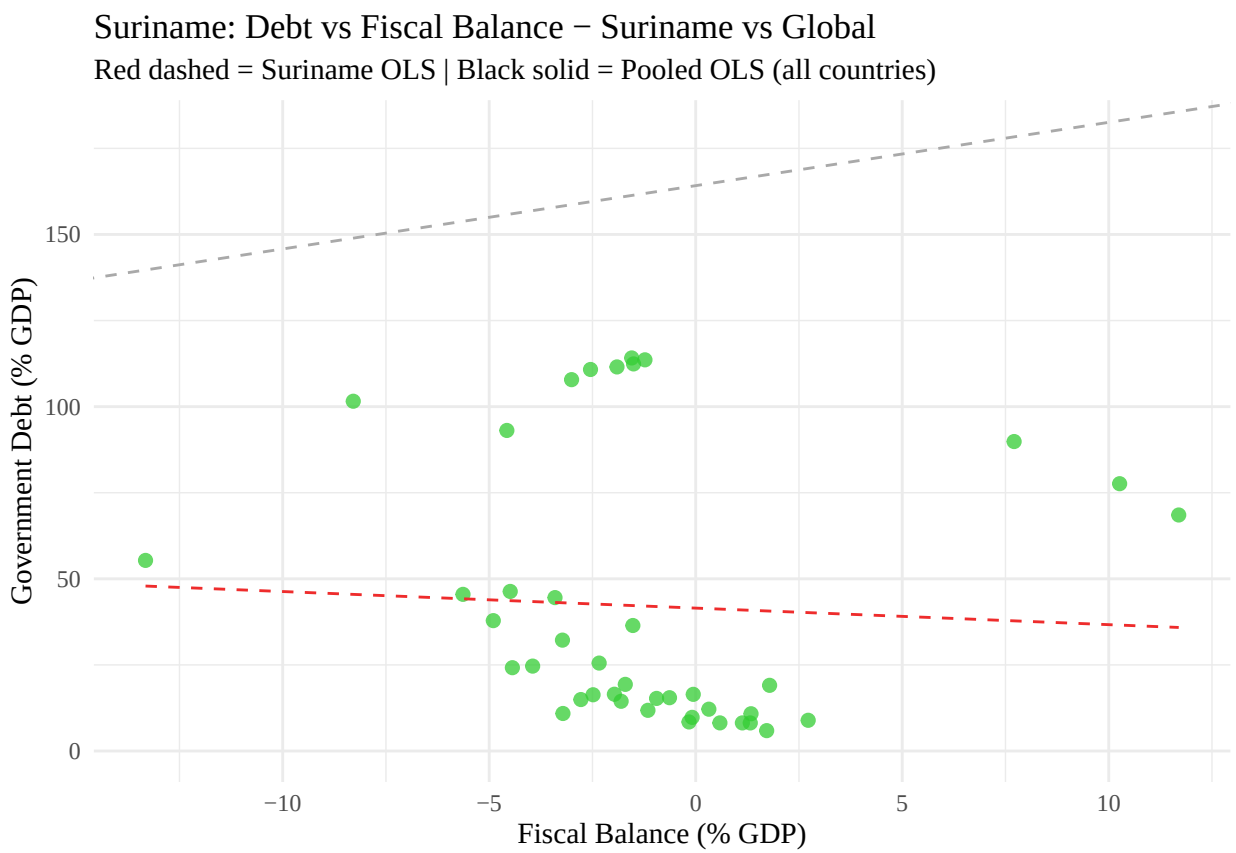
```
##
## Residual standard error: 250.7 on 231 degrees of freedom
## Multiple R-squared:  0.3251, Adjusted R-squared:  0.3222
## F-statistic: 111.3 on 1 and 231 DF,  p-value: < 2.2e-16
```

```
# 4) Suriname-only OLS
df_sur <- df_reg %>% filter(country == "Suriname")
model_sur <- lm(gov_debt_gdp ~ fiscal_balance_gdp, data = df_sur)
summary(model_sur)
```

```
##
## Call:
## lm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_sur)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -34.76 -29.21 -19.44  32.66  71.90
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)         41.4962     6.2696   6.619 7.18e-08 ***
## fiscal_balance_gdp  -0.4806     1.4275  -0.337    0.738
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 38.68 on 39 degrees of freedom
## Multiple R-squared:  0.002898,   Adjusted R-squared:  -0.02267
## F-statistic: 0.1133 on 1 and 39 DF,  p-value: 0.7382
```

```
# 5) Plot: Suriname scatter + Suriname fit + pooled global fit
ggplot(df_sur, aes(x = fiscal_balance_gdp, y = gov_debt_gdp)) +
  geom_point(color = "#32CD32", size = 2, alpha = 0.75) +
  geom_smooth(method = "lm", se = FALSE, color = "#EE2C2C", linetype = "dashed", size = 0.5) + # Surina
  geom_abline(
    intercept = coef(model_pooled_lm)[1],
    slope     = coef(model_pooled_lm)[2],
    color     = "darkgrey", #global line
    linetype  = "dashed",
    size      = 0.5
  ) +
  coord_cartesian(ylim = c(0, 180)) +  # adjust this based on intercept size
  labs(
    title = "Suriname: Debt vs Fiscal Balance - Suriname vs Global",
    subtitle = "Red dashed = Suriname OLS | Black solid = Pooled OLS (all countries)",
    x = "Fiscal Balance (% GDP)",
    y = "Government Debt (% GDP)"
  ) +
  theme_minimal(base_family = "serif")
```

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



As can be seen in the graph above, Suriname deviated from the global (pooled) slope which is positive, while Suriname's slope is negative. What is expected: the slope on fiscal_balance_gdp should be negative: higher fiscal balance (surplus) should lead to lower debt ratios. Norway is most likely biasing the data (explained in the report).

C.4.1 Sensitivity check - Is Norway driving the global slope?

In order to verify this, the global regression is run without Norway and the slope and significance is compared to the baseline model.

```
# Checking Norway's impact and rerun the global regression
df_reg_no_norway <- df_reg %>% filter(country != "Norway")

model_debt_fb_no_norway <- plm(
  gov_debt_gdp ~ fiscal_balance_gdp,
  data = df_reg_no_norway,
  index = c("country", "year"),
  model = "within"
)
```

The baseline model

```
summary(model_debt_fb) #slope 1.56849
```

```
## Oneway (individual) effect Within Model
```

```
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = pdata,
##     model = "within")
##
## Unbalanced Panel: n = 6, T = 30-51, N = 233
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -406.853 -140.846  -15.331   21.761  803.316
##
## Coefficients:
##                    Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp  1.56849    0.18613  8.4269 4.167e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    12396000
## Residual Sum of Squares: 9432400
## R-Squared:      0.23909
## Adj. R-Squared: 0.21889
## F-statistic: 71.0132 on 1 and 226 DF, p-value: 4.1673e-15
```

The baseline model without Norway

```
summary(model_debt_fb_no_norway) #slope -4.78468 (flipped!)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_reg_no_norway,
##     model = "within", index = c("country", "year"))
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -459.887  -48.656  -18.474   17.520  758.398
##
## Coefficients:
##                    Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -4.78468    0.38696 -12.365 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 2575600
## R-Squared:      0.46486
## Adj. R-Squared: 0.44966
## F-statistic: 152.888 on 1 and 176 DF, p-value: < 2.22e-16
```

The model for Suriname

```r
summary(model_sur) #slope -0.4806
```

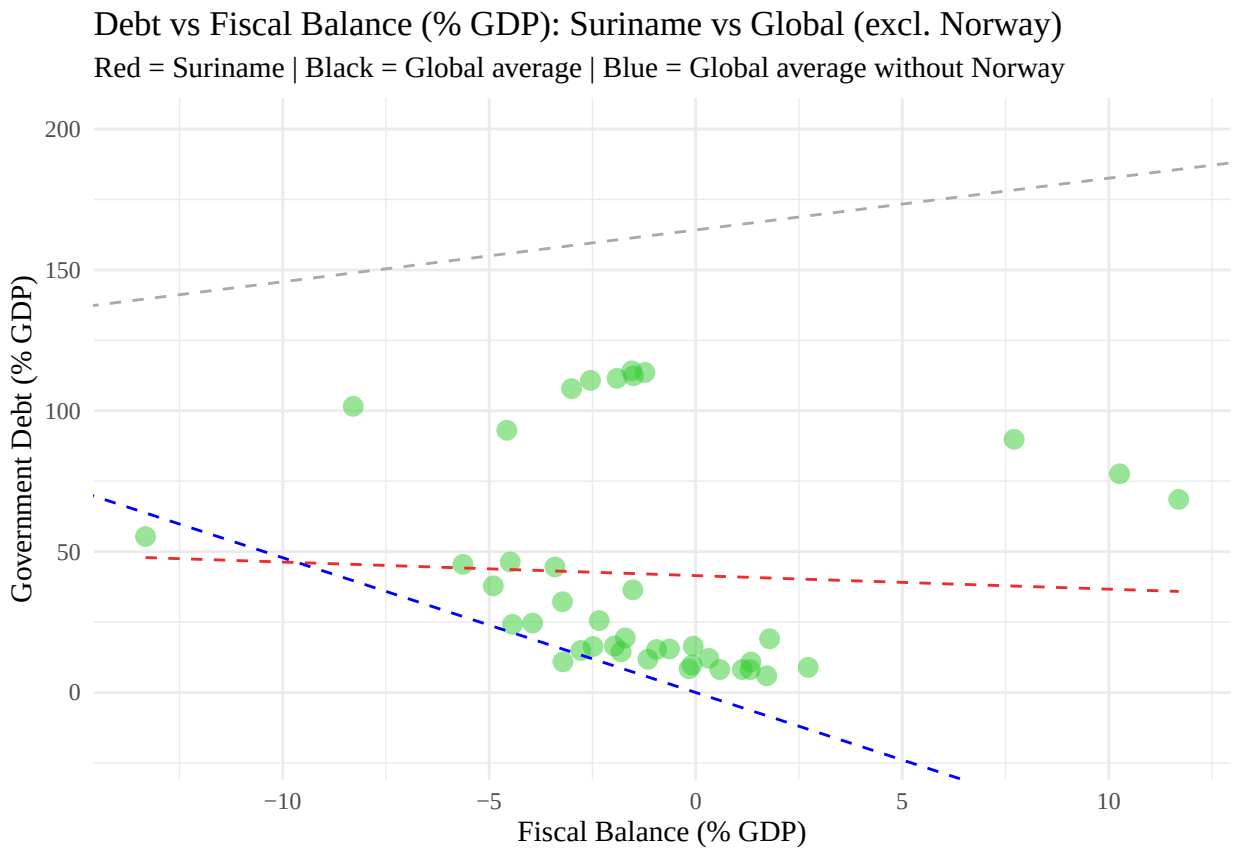
```
##
## Call:
## lm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_sur)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -34.76 -29.21 -19.44  32.66  71.90
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)         41.4962     6.2696   6.619 7.18e-08 ***
## fiscal_balance_gdp  -0.4806     1.4275  -0.337    0.738
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 38.68 on 39 degrees of freedom
## Multiple R-squared:  0.002898,   Adjusted R-squared:  -0.02267
## F-statistic: 0.1133 on 1 and 39 DF,  p-value: 0.7382
```

What this means for Suriname: 1. Globally (without Norway), fiscal discipline (better balance) is strongly linked to lower debt burdens. 2. Suriname's negative slope matches the global sign now — earlier, Norway was biasing the global slope positive. 3. This validates that Suriname actually behaves similarly to other resource economies: when balance improves, debt falls.

```r
#So Norway was driving the global slope. We continue without Norway
#for it is biasing the data

# 3. Visualization: Suriname vs Global (no Norway)
ggplot(df_sur, aes(x = fiscal_balance_gdp, y = gov_debt_gdp)) +
  geom_point(color = "#32CD32", size = 3, alpha = 0.5) +

  # Suriname fit
  geom_smooth(method = "lm", se = FALSE, color = "#EE2C2C", linetype = "dashed", size = 0.5) +

  # Global fit (no Norway)
  geom_abline(
    slope = coef(model_debt_fb_no_norway)[1],
    color = "blue",
    linetype = "dashed"
  ) +

  # Global fit (All countries)
  geom_abline(
    intercept = coef(model_pooled_lm)[1],
    slope = coef(model_pooled_lm)[2],
    color = "darkgrey",
    linetype = "dashed"
  ) +
  coord_cartesian(ylim = c(-20, 200)) +  # adjust this based on intercept size
  labs(
    title = "Debt vs Fiscal Balance (% GDP): Suriname vs Global (excl. Norway)",
```

```
    subtitle = "Red = Suriname | Black = Global average | Blue = Global average without Norway",
    x = "Fiscal Balance (% GDP)",
    y = "Government Debt (% GDP)"
  ) +
  theme_minimal(base_family = "serif")
```

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



The corrected global model (without Norway) will be used as the main comparison for Suriname going forward.

C.4.2 Extending the model with controls

In this subsection, the model will be extended with controls to see if the negative slope (more fiscal deficit leading to higher debt) remains significant once we account for other drivers.

```
# Extend the model with controls to check if the debt-balance relationship holds
# after controlling for these.
# Candidate control variables: GDP Growth, Inflation, Natural Resource rents,
# First data need to be imported from the Natural resource rents data from WDI
# because it's not in the IMF WOE Dataset.


# Install & load package if not yet done for WDI data: Natural resource rents (% GDP)
```

```r
# Indicator code: NY.GDP.TOTL.RT.ZS for Natural resource rents

if (!requireNamespace("WDI", quietly = TRUE)) install.packages("WDI")
library(plm)
library(WDI)
library(dplyr)

# Note! The WDI API can be very unstable with temporary outages
# - these happen every few weeks, and are usually fix themselves within 24-72 hours.
# Therefore, the data frame from previous runs was saves as a separate object and imported
# so the code would not break down.
# The code to download it from the worldbank is commented.
# The comments can be removed to download it. from the WDI API

# wdi_rents <- WDI(
#  country = "all",
#  indicator = "NY.GDP.TOTL.RT.ZS",
#  start = max(panel$year, na.rm = TRUE),
#  end   = max(panel$year, na.rm = TRUE),
#  extra = FALSE,
#  cache = NULL
#)
```

```
## # A tibble: 306 x 10
##    country  year current_account_gdp gdp_growth gov_debt_gdp gov_expenditure_gdp
##    <chr>   <int>               <dbl>      <dbl>        <dbl>                <dbl>
##  1 Azerba~  1980                 NaN        NaN          NaN                  NaN
##  2 Azerba~  1981                 NaN        NaN          NaN                  NaN
##  3 Azerba~  1982                 NaN        NaN          NaN                  NaN
##  4 Azerba~  1983                 NaN        NaN          NaN                  NaN
##  5 Azerba~  1984                 NaN        NaN          NaN                  NaN
##  6 Azerba~  1985                 NaN        NaN          NaN                  NaN
##  7 Azerba~  1986                 NaN        NaN          NaN                  NaN
##  8 Azerba~  1987                 NaN        NaN          NaN                  NaN
##  9 Azerba~  1988                 NaN        NaN          NaN                  NaN
## 10 Azerba~  1989                 NaN        NaN          NaN                  NaN
## # i 296 more rows
## # i 4 more variables: gov_revenue_gdp <dbl>, inflation <dbl>,
## #   fiscal_balance_gdp <dbl>, resource_rents_gdp <dbl>
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_reg_no_norway,
##     model = "within", index = c("country", "year"))
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -459.887  -48.656  -18.474   17.520  758.398
##
## Coefficients:
```

```
##                     Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -4.78468    0.38696 -12.365 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 2575600
## R-Squared:      0.46486
## Adj. R-Squared: 0.44966
## F-statistic: 152.888 on 1 and 176 DF, p-value: < 2.22e-16

## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth,
##     data = pdata_growth, model = "within")
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -208.0798  -29.2035   -7.1115   13.5135  499.7312
##
## Coefficients:
##                     Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -1.829994   0.429411 -4.2616  3.31e-05 ***
## gdp_growth          0.132257   0.013294  9.9487 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 1645200
## R-Squared:      0.65819
## Adj. R-Squared: 0.64647
## F-statistic: 168.488 on 2 and 175 DF, p-value: < 2.22e-16

## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + inflation,
##     data = pdata_infl, model = "within")
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -405.8859  -42.1650   -7.8062   29.2804  732.9963
##
## Coefficients:
##                     Estimate Std. Error  t-value  Pr(>|t|)
## fiscal_balance_gdp -4.372791   0.324222 -13.4870 < 2.2e-16 ***
## inflation           0.568916   0.063287   8.9895 3.961e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 1762000
## R-Squared:      0.63391
## Adj. R-Squared: 0.62136
## F-statistic: 151.515 on 2 and 175 DF, p-value: < 2.22e-16

## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + resource_rents_gdp,
##     data = pdata_rents, model = "within")
##
## Unbalanced Panel: n = 5, T = 10-32, N = 126
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -64.2830 -12.0467  -4.7923   8.9599  79.9744
##
## Coefficients:
##                     Estimate Std. Error  t-value Pr(>|t|)
## fiscal_balance_gdp -3.50465    0.24269 -14.4411  < 2e-16 ***
## resource_rents_gdp -0.40414    0.21206  -1.9058  0.05909 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    162730
## Residual Sum of Squares: 59097
## R-Squared:      0.63683
## Adj. R-Squared: 0.61852
## F-statistic: 104.337 on 2 and 119 DF, p-value: < 2.22e-16

## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth +
##     inflation + resource_rents_gdp, data = pdata_all, model = "within")
##
## Unbalanced Panel: n = 5, T = 10-32, N = 126
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -62.34307  -8.89105  -0.68279   9.43590  75.29523
##
## Coefficients:
##                      Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -2.205368   0.330406 -6.6747 8.713e-10 ***
## gdp_growth          0.115790   0.037841  3.0599  0.002746 **
## inflation           0.353625   0.055842  6.3326 4.630e-09 ***
## resource_rents_gdp -0.260794   0.183550 -1.4208  0.158023
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    162730
```

```
## Residual Sum of Squares: 42905
## R-Squared:      0.73634
## Adj. R-Squared: 0.71831
## F-statistic: 81.6873 on 4 and 117 DF, p-value: < 2.22e-16
```

We keep the global model (no Norway) and add one control at a time. The summary for the global model (as presented previously)

```
summary(model_debt_fb_no_norway)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp, data = df_reg_no_norway,
##     model = "within", index = c("country", "year"))
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -459.887  -48.656  -18.474   17.520  758.398
##
## Coefficients:
##                     Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -4.78468    0.38696 -12.365 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 2575600
## R-Squared:      0.46486
## Adj. R-Squared: 0.44966
## F-statistic: 152.888 on 1 and 176 DF, p-value: < 2.22e-16
```

Controlling for Growth

```
summary(model_debt_fb_gdp)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth,
##     data = pdata_growth, model = "within")
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -208.0798  -29.2035   -7.1115   13.5135  499.7312
##
## Coefficients:
##                     Estimate Std. Error t-value  Pr(>|t|)
```

```
## fiscal_balance_gdp -1.829994   0.429411 -4.2616  3.31e-05 ***
## gdp_growth          0.132257   0.013294  9.9487 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 1645200
## R-Squared:      0.65819
## Adj. R-Squared: 0.64647
## F-statistic: 168.488 on 2 and 175 DF, p-value: < 2.22e-16
```

Controlling for inflation

```
summary(model_debt_fb_infl)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + inflation,
##     data = pdata_infl, model = "within")
##
## Unbalanced Panel: n = 5, T = 30-41, N = 182
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -405.8859  -42.1650   -7.8062   29.2804  732.9963
##
## Coefficients:
##                     Estimate Std. Error  t-value  Pr(>|t|)
## fiscal_balance_gdp -4.372791   0.324222 -13.4870 < 2.2e-16 ***
## inflation           0.568916   0.063287   8.9895 3.961e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    4813000
## Residual Sum of Squares: 1762000
## R-Squared:      0.63391
## Adj. R-Squared: 0.62136
## F-statistic: 151.515 on 2 and 175 DF, p-value: < 2.22e-16
```

Controlling for Natural resource rents

```
summary(model_debt_fb_rents)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + resource_rents_gdp,
##     data = pdata_rents, model = "within")
##
## Unbalanced Panel: n = 5, T = 10-32, N = 126
##
```

```
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -64.2830 -12.0467  -4.7923   8.9599  79.9744
##
## Coefficients:
##                    Estimate Std. Error  t-value Pr(>|t|)
## fiscal_balance_gdp -3.50465    0.24269 -14.4411  < 2e-16 ***
## resource_rents_gdp -0.40414    0.21206  -1.9058  0.05909 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    162730
## Residual Sum of Squares: 59097
## R-Squared:      0.63683
## Adj. R-Squared: 0.61852
## F-statistic: 104.337 on 2 and 119 DF, p-value: < 2.22e-16
```

Controlling for All control toghether

```
summary(model_debt_fb_controls)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth +
##     inflation + resource_rents_gdp, data = pdata_all, model = "within")
##
## Unbalanced Panel: n = 5, T = 10-32, N = 126
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -62.34307  -8.89105  -0.68279   9.43590  75.29523
##
## Coefficients:
##                     Estimate Std. Error t-value  Pr(>|t|)
## fiscal_balance_gdp -2.205368   0.330406 -6.6747 8.713e-10 ***
## gdp_growth          0.115790   0.037841  3.0599  0.002746 **
## inflation           0.353625   0.055842  6.3326 4.630e-09 ***
## resource_rents_gdp -0.260794   0.183550 -1.4208  0.158023
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    162730
## Residual Sum of Squares: 42905
## R-Squared:      0.73634
## Adj. R-Squared: 0.71831
## F-statistic: 81.6873 on 4 and 117 DF, p-value: < 2.22e-16
```

Next step would be to compare Suriname's regression results (OLS with controls) to these global coefficients, that way, it can be tested to what extend Suriname differs.

```r
# Suriname-only regression with controls
df_sur_all <- panel_ext %>%
  filter(country == "Suriname") %>%
  select(year, gov_debt_gdp, fiscal_balance_gdp, gdp_growth, inflation, resource_rents_gdp) %>%
  filter(!is.na(gov_debt_gdp) & !is.na(fiscal_balance_gdp) &
           !is.na(gdp_growth) & !is.na(inflation) & !is.na(resource_rents_gdp))

model_sur_controls <- lm(gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth + inflation + resource_rents_gdp
summary(model_sur_controls)
```

```
##
## Call:
## lm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth +
##     inflation + resource_rents_gdp, data = df_sur_all)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -30.0023  -6.3675   0.2025   4.5000  22.9407
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)        13.55650    6.58605   2.058   0.0493 *
## fiscal_balance_gdp -2.48153    0.69174  -3.587   0.0013 **
## gdp_growth         -1.23679    0.54712  -2.261   0.0321 *
## inflation           0.38829    0.05772   6.727 3.19e-07 ***
## resource_rents_gdp  0.07451    0.26801   0.278   0.7831
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.06 on 27 degrees of freedom
## Multiple R-squared:  0.8335, Adjusted R-squared:  0.8089
## F-statistic:  33.8 on 4 and 27 DF,  p-value: 3.771e-10
```

```r
summary(model_sur_controls)
```

```
##
## Call:
## lm(formula = gov_debt_gdp ~ fiscal_balance_gdp + gdp_growth +
##     inflation + resource_rents_gdp, data = df_sur_all)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -30.0023  -6.3675   0.2025   4.5000  22.9407
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)        13.55650    6.58605   2.058   0.0493 *
## fiscal_balance_gdp -2.48153    0.69174  -3.587   0.0013 **
## gdp_growth         -1.23679    0.54712  -2.261   0.0321 *
## inflation           0.38829    0.05772   6.727 3.19e-07 ***
## resource_rents_gdp  0.07451    0.26801   0.278   0.7831
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.06 on 27 degrees of freedom
## Multiple R-squared:  0.8335, Adjusted R-squared:  0.8089
## F-statistic:  33.8 on 4 and 27 DF,  p-value: 3.771e-10
```