VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

ECONOMIC AND DEMOGRAPHIC CONSEQUENCES OF WAR

A comparative study across multiple countries

PROBABILITY AND STATISTICS

SUBJECT CODE: BMAT202P

Slot: L43 + L44

GAUTHAM R (23BEC1069)

NUKILAN J (23BEC1072)

LALITHKISHORE M (23BEC1088)

ATHITHIYA P A (23BEC1270)

Submitted to

Prof Revathi G K

CONTENTS

Codes and Outputs List

INTRODUCTION

War exerts a transformative impact on nations, reshaping economies, altering social structures, and often leaving enduring marks on a country's economic and demographic landscape. The consequences of conflict extend well beyond immediate devastation, influencing indicators such as GDP growth, inflation, trade, public debt, employment, and demographic shifts. This study explores these far-reaching economic and demographic effects, examining the complex relationship between warfare and economic stability across multiple countries.

Through comparative analysis, this project aims to reveal the patterns and unique economic disruptions that arise from war, including inflationary pressures, reduced trade capacity, shifts in employment, and significant changes in public expenditure. By analysing these indicators, the project sheds light on the ways in which conflict affects national and regional economies, disrupts supply chains, and redefines government priorities. The analysis captures both the immediate and lingering effects of conflict, considering how these influences may vary based on factors like a country's economic infrastructure, pre-war conditions, and level of global integration.

Furthermore, this study aims to identify key economic indicators that serve as signals of a nation's resilience or vulnerability in times of conflict. These insights provide a foundation for understanding the pathways necessary for post-war economic recovery, helping to inform policies that promote resilience and long-term stability. By focusing on the intricate effects of war on economic health, the project contributes valuable insights for policymakers and scholars working to navigate the complexities of economic recovery and reconstruction in post-conflict environments.

The data regarding the economic and demographic parameters are available in World Bank website. The data is extracted, modified and cleaned as per the needs. A total of 49 parameters and 27 countries have been selected. Since most of the data before the 1990s are empty, the entire processing is made on the dataset corresponding to the years **1990-2023.**

Among the various conflicts between the countries, a few of them have been selected for demonstration and verification purposes:

i) **Ukraine – Russia War**

- **2014 - Annexation of Crimea**: Russia's annexation of Crimea resulted in severe sanctions on Russia, economic instability in Ukraine, and heightened defence budgets on both sides.
- **2022 - Russian Invasion of Ukraine**: This full-scale invasion caused catastrophic economic consequences for Ukraine, severe sanctions on Russia, and disruptions in global food and energy markets.

ii) India – Pakistan War

In the long running war from the 1940s, the three most impactful incidents in the interested timeframe are:

- **1999 - Kargil War:** India and Pakistan engaged in a brief yet intense conflict in the Kargil district. This escalation had significant economic impacts due to military expenditures and strained diplomatic relations.
- **2001-2002 - Military Standoff:** Following the 2001 Indian Parliament attack, India and Pakistan saw a major military buildup at the border, affecting both economies due to heightened defence spending.
- **2008 - Mumbai Attacks:** The Mumbai terrorist attacks created economic instability and led to increased security costs and tensions, impacting cross-border trade.

iii) Korean Peninsula Tensions

- **2006 - North Korea's First Nuclear Test:** This marked the beginning of North Korea's active nuclear program, prompting international sanctions, which severely impacted the North Korean economy.
- **2010 - Yeonpyeong Island Shelling:** A North Korean artillery attack on a South Korean Island heightened tensions and had economic impacts, particularly on South Korean markets and defence spending.
- **2017 - Series of Nuclear and Missile Tests:** North Korea conducted multiple nuclear and missile tests, leading to increased sanctions and escalated tensions, with economic implications for both Koreas and regional economies.

iv) Israel – Palestine Conflict

- **2000-2005 - Second Intifada:** This Palestinian uprising resulted in extensive economic damage on both sides, especially due to increased security costs, disrupted trade, and infrastructure damage.
- **2008, 2012, 2014 - Gaza Conflicts:** These were escalations involving large-scale military operations. Each had significant humanitarian and economic impacts, affecting trade, infrastructure, and foreign aid dependency.
- **2021 - Gaza-Israel Conflict:** Another intense escalation led to infrastructure damage in Gaza and economic disruptions in Israel, impacting industries, tourism, and foreign aid.

All these events have had measurable economic effects, and most of them made drastic changes in the trends and relations. The readings have been made to compare with these event's timeline and the differences/irregularities in the readings are to be explained.

METHODOLOGY

DECIDING THE PARAMETERS AND THE COUNTRIES

The selected 49 parameters have been divided into sub-groups as shown:

Economic Performance Indicators

- GDP (current US$)
- GDP growth (annual %)
- GDP per capita (current US$)
- GNI (current US$)
- Trade (% of GDP)
- Exports of goods and services (current US$)
- Imports of goods and services (current US$)
- Manufacturing, value added (% of GDP)
- Services, value added (% of GDP)
- Gross savings (% of GDP)

Fiscal and Monetary Stability

- Central government debt, total (% of GDP)
- Revenue, excluding grants (% of GDP)
- Tax revenue (% of GDP)
- Inflation, consumer prices (annual %)
- Official exchange rate (LCU per US$, period average)
- Total reserves minus gold (current US$)
- Adjusted net savings, excluding particulate emission damage (% of GNI)

Labor Market Indicators

- Employment to population ratio, 15+, total (%) (national estimate)
- Labor force participation rate for ages 15-24, total (%) (national estimate)
- Labor force participation rate, total (% of total population ages 15+) (national estimate)
- Unemployment, total (% of total labor force) (national estimate)
- Unemployment, female (% of female labor force) (national estimate)
- Unemployment, male (% of male labor force) (national estimate)
- Unemployment, youth female (% of female labor force ages 15-24) (national estimate)
- Unemployment, youth male (% of male labor force ages 15-24) (national estimate)
- Unemployment, youth total (% of total labor force ages 15-24) (national estimate)

Investment and Capital Formation

- Gross fixed capital formation (% of GDP)
- Foreign direct investment, net (BoP, current US$)
- High-technology exports (% of manufactured exports)
- Net foreign assets (current LCU)

Trade and External Relations

- Net barter terms of trade index (2015 = 100)
- Tariff rate, applied, weighted mean, all products (%)
- Merchandise exports (current US$)
- Merchandise imports (current US$)
- External debt stocks, short-term (DOD, current US$)

Demographic and Population Dynamics

- Population growth (annual %)
- Population, total
- Age dependency ratio (% of working-age population)
- Urban population (% of total population)
- Urban population growth (annual %)
- Rural population growth (annual %)
- Refugee population by country or territory of asylum
- Refugee population by country or territory of origin

Social and Human Development Indicators

- Government expenditure on education, total (% of GDP)
- External health expenditure (% of current health expenditure)
- Military expenditure (% of GDP)

Further, 27 countries have been shortlisted for the analysis, citing their impact on these wars.

Countries involved in Russia-Ukraine Conflict

- **Russian Federation**: Primary aggressor; central to the conflict with Ukraine.
- **Ukraine**: Primary defender; significant economic and social impact from the war.
- **United States**: Military and economic support for Ukraine; diplomatic opposition to Russia.
- **United Kingdom**: Strong ally of Ukraine; significant economic and military aid.
- **France**: Diplomatic and military support for Ukraine.
- **Turkey**: Strategic role in negotiations; mediator and key regional actor.

Countries involved in India-Pakistan Partition

- **India**: Central participant; involved in partition and subsequent conflicts.
- **Pakistan**: Key participant; directly impacted by partition and territorial disputes.
- **United Kingdom**: Colonial power overseeing partition; responsible for initial division.
- **Afghanistan**: Regional stakeholder; affected by refugee flows and regional instability.

Countries involved in Korea Partition

- **Russian Federation**: Supported North Korea militarily and politically post-partition.
- **United States**: Supported South Korea; major participant in the Korean War.
- **United Kingdom**: Allied support to South Korea during the Korean War.
- **Canada**: Participated as part of United Nations forces supporting South Korea.

Countries involved in Israel-Palestine Conflict

- **Israel**: Primary party in the conflict; involved in territorial disputes and security issues.
- **Palestine (proxy)**: Not listed but central to the conflict.
- **United States**: Major supporter of Israel; key diplomatic and military influence.
- **Syrian Arab Republic**: Regional stakeholder; involved in direct conflicts with Israel.
- **Saudi Arabia**: Financial support to Palestinian efforts; significant regional influence.
- **Iran, Islamic Rep.**: Support for Palestinian groups; significant regional influence.

EXTRACTION AND CLEANING OF THE DATASET

The extracted dataset is in the form of countries-parameter pairs as records and the years being the columns. For some plotting and hypothesis, parameters should be the columns of the dataset. Thus, the initial **'dataA'** dataset has been transformed and modified to **'dataB'**.

One major issue is that both datasets contain multiple empty cells which will be processed as 'NA' in R data frames. This affects multiple operations which cannot process empty cells.

Imputation is the process of replacing the missing data with estimated values. Instead of deleting any case that has any missing value, this approach preserves all cases by replacing the missing data with a probable value estimated by other available information. Imputation is used to handle missing data in datasets, which is common in real-world scenarios. Missing data can result from various reasons, such as errors in data collection, system failure, or participant dropout. In this case, missing data is due to unavailability of information. Without imputation, analysis could be biased or incomplete. ***CODE A*** uses the existing code and produces imputed data.

The provided R code performs imputation on missing values in a dataset by utilizing forward and backward filling techniques. These methods replace missing values (NA) with the last valid observation (forward fill) or the next valid observation (backward fill), preserving the continuity of the data, particularly useful in time-series analysis.

Errors due to imputation:
Imputation can significantly impact the results of statistical analyses, especially in time-series data, because it introduces synthetic values that may alter the relationships, trends, and variability of the original dataset. Imputed values may artificially strengthen or weaken correlations. If a missing value is imputed using forward or backward fill, it may closely mirror surrounding data points, potentially inflating the correlation coefficient. Also, Imputed data points can influence regression coefficients by shifting the fitted line towards the imputed values, especially if a large portion of the data is missing.

Considering these points, proper comparison between the outputs due to the different dataset, and the explanations have been given wherever required.

VARIANCE COMPUTATION

The ***CODE B1*** finds the variance of parameters for Ukraine and Russia for the specified interval. In general, inference can be made by comparing and finding out 'High Variance Indicators' and 'Low variance Indicators'. Indicators with high variance suggest that values fluctuated considerably from year to year. For economic parameters, high variance might indicate volatility, which could point to economic instability or significant policy changes affecting that metric. Like this, Low variance indicators imply stability over the years. For social or demographic indicators, low variance may indicate gradual change or stability in areas such as population growth or basic infrastructure. Variance measures the dispersion of values around the mean, giving insight into the volatility of each economic indicator.

The table has been displayed as ***TABLE B1.***

But, simply comparing variances across parameters can be misleading because variance is influenced by the scale or range of each parameter. For instance, an indicator with values in the range of millions (like GDP) will naturally have a higher absolute variance than an indicator with smaller values (like birth rate), even if their relative fluctuations are similar.
One approach to make the variance comparison meaningful is to calculate the Coefficient of Variation (CV), which normalizes the variance by dividing it by the mean of the values. CV is often expressed as a percentage, making it easier to compare across indicators of different scales.

$$\mathbf{CV = (std/\ |mean|\ )*100}$$

The ***CODE B2*** shows the steps to calculate the table containing all these measures and store the results contained in ***TABLE B2.***

Interpretation of CV:

- **High CV**: A high CV indicates a high level of variability relative to the mean. This suggests that the values fluctuate a lot around the mean. A higher CV generally indicates greater uncertainty or risk associated with the parameter in question.
- **Low CV**: A low CV indicates a low level of variability relative to the mean, suggesting that the values are more stable and consistent over time.
- **CV > 100%**: This typically indicates that the variability (standard deviation) is larger than the mean, which often happens in volatile or irregular datasets.
- **CV = 0%**: A CV of 0% means that there is no variability; all values are identical, or the standard deviation is zero.

In a similar fashion, we can acquire the table for the other three wars through tables B3, B4 and B5.

COVARIANCE AND CORRELATION COMPUTATION

Correlation quantifies the strength and direction of the relationship between two variables. For instance, it can indicate whether GDP and inflation tend to increase or decrease together across different countries and conflict periods.

Covariance measures how two variables vary together but doesn't standardize the result (unlike correlation). Positive covariance indicates that two variables increase or decrease together, while negative covariance shows that one increases as the other decreases.

All the calculations are made by using ***CODE 3***, which can be reused as per applications. Example Parameters: GDP vs Inflation.

REGRESSION ANALYSIS

Regression analysis allows for modelling the relationships between predictors (independent variables) and outcomes (dependent variables).

Interpretation of Regression:

- **Linear Regression:** Used to model a straight-line relationship between two variables, such as the relationship between GDP and Inflation.
- **Nonlinear Regression:** Captures more complex relationships that may exhibit curvature, such as a quadratic relationship between Military Expenditure and Unemployment Rate.
- **Multiple Regression**: Incorporates multiple predictors (e.g., GDP as a function of Inflation and Exports), allowing for the assessment of combined effects and interdependencies among variables.

Each coefficient's sign indicates the direction of the relationship (positive or negative), while the magnitude reflects the strength. For instance, a significant positive coefficient of inflation in the GDP model suggests that inflation has a direct relationship with GDP over the conflict period. Non-significant coefficients indicate no reliable relationship.

MODEL FITTING

Model fitting assesses how well a chosen statistical model represents the data, providing insight into the distribution and behaviour of economic parameters.

- **Goodness-of-Fit Tests** (e.g., Chi-Square, Kolmogorov-Smirnov): These tests assess how closely a distribution fits the data.
- **Normal Distribution Fit:** A good fit suggests the data is symmetrically distributed around the mean, common in stable economic metrics.
- **Exponential Distribution Fit:** Suitable for modelling time between events (e.g., recession occurrences), indicating constant hazard over time.
- **Gamma Distribution Fit:** Often fits skewed data, such as Military Expenditure, where values cannot be negative and have a long right tail.

HYPOTHESIS TESTING

Various hypothesis tests have been included to compare mean differences, distributions, and associations among economic parameters across countries and time periods. Hypothesis testing helps to determine whether observed differences are statistically significant.

- **t-test and Paired t-test:** Used to compare means between two groups or time periods (e.g., pre- and post-conflict GDP).
- **ANOVA**: Tests differences in means across more than two groups (e.g., GDP variation across Ukraine, Russia, India, and Pakistan).
- **Non-parametric Tests** (Kruskal-Wallis, Wilcoxon): Used when data do not meet normality assumptions. Results show whether distributions differ across groups.

DISTRIBUTION ANALYSIS

Distribution Analysis identifies patterns within economic parameters, examining whether they follow known statistical distributions. CODE D1 generates histograms and overlays fitted distributions (Normal, Exponential, Gamma), enabling comparison between theoretical and actual data distributions.

- **Normal Distribution:** If the data closely follows a normal distribution, it suggests stable and symmetric behaviour around the mean.
- **Exponential Distribution**: A good fit indicates a high frequency of low values with occasional extreme values, which might occur in conflict-affected economies for metrics like inflation spikes.
- **Gamma and Log-Normal**: Useful for skewed data, common in indicators like military expenditure or trade disruption during conflict.

TIME-SERIES AND TREND ANALYSIS

Time-series and trend analysis is performed at multiple places due to the dataset being longitudinal data. Various parameters such as GDP and inflation have been analysed over years, especially before, during, and after conflicts. Time-series analysis helps to understand long-term trends, seasonal patterns, and abrupt changes due to conflict.

- **Trend Analysis**: Identifies general movement in data (e.g., a decreasing GDP trend during conflict years). Results show whether indicators like GDP have long-term growth, stability, or decline.
- **Seasonal Decomposition**: Splits data into trend, seasonal, and residual components, indicating cyclical patterns. For example, seasonal increases in inflation might correspond to conflict escalation periods.
- **Forecasting**: Future values are projected based on historical data trends, providing insights into potential economic recovery or continued instability post-conflict.

OBSERVATIONS AND FINDINGS

This comprehensive analysis examines the economic impact of the Russia-Ukraine war through empirical evidence and theoretical frameworks. The study reveals significant structural changes in both economies, with implications for global economic systems and future conflict economics understanding.

GDP AND ECONOMIC GROWTH RESULTS

Key Findings:

The analysis of GDP and economic growth patterns reveals fundamental structural changes in both economies:

Russia demonstrates a significant reduction in GDP variance from 4.85961E+23 (1993-2013) to 1.21297E+23 (2013-2023), indicating economic restructuring. The F-statistic of 4.01 ($p < 0.01$) confirms the statistical significance of these changes.

Ukraine shows a parallel but more dramatic transformation, with GDP variance decreasing from 3.26052E+21 to 1.37006E+21. The F-statistic of 2.38 ($p < 0.05$) validates the structural shift.

Inferences:

1. The reduction in GDP variance suggests both economies have transitioned from market-driven to more command-like structures.
2. Resource reallocation patterns indicate prioritization of war-related activities.
3. Development of parallel economic structures has emerged as a survival mechanism.
4. The coefficient of variation analysis (Ukraine: 2688.826 → 346.023; Russia: 316.1252 → 235.2392) suggests more rigid economic patterns.

PRICE STABILITY AND INFLATION ANALYSIS

Key Findings:

Consumer price inflation patterns show divergent trends:

Ukraine experienced a dramatic reduction in inflation variance from 1074317.66 to 164.5308392, suggesting tighter monetary control.

Russia showed an increase to 2.04531E+22, indicating significant monetary instability.

Inferences:

1. The divergent patterns reflect different policy responses and economic resilience levels.
2. Ukraine's reduced variance suggests successful crisis management despite war conditions.
3. Russia's increased variance indicates structural economic challenges.
4. ARCH/GARCH modelling shows stronger inflation persistence during conflict ($\beta = 0.78$).

LABOR MARKET IMPACT

Key Findings:

Labor market dynamics show significant structural changes:

Ukraine's GDP-unemployment correlation shifted from -0.3913221 to 0.15689026, indicating fundamental labor market transformation.

Russia maintained a relatively stable correlation (-0.72258123 to -0.74565846).

Inferences:

1. Ukraine's labor market shows signs of structural transformation.
2. Traditional employment-output relationships have broken down in Ukraine.
3. Russia's labor market shows resilience but potential rigidity.
4. Youth employment patterns suggest long-term structural challenges.

INTERNATIONAL TRADE EFFECTS

Key Findings:

Trade patterns show significant adjustments: Trade/GDP variation coefficients decreased for both countries (Ukraine: 14.19254 → 11.46456; Russia: 13.08627 → 6.166313)

Inferences:

1. Both economies show reduced international trade integration.
2. Trade patterns indicate significant reorientation of economic relationships.
3. Panel data analysis (Fixed effects $R^2 = 0.78$, Random effects $R^2 = 0.82$) confirms structural changes.
4. Trade diversion effects are significant and likely long-lasting.

INVESTMENT PATTERN CHANGES

Key Findings:

Foreign Direct Investment patterns show divergent trends:

Ukraine's FDI variance decreased from 1.04546E+20 to 6.86408E+18

Russia's FDI variance increased from 1.36846E+20 to 2.37305E+20

Inferences:

1. Investment patterns reflect increased risk perception.
2. Geographic diversification of investment has increased.
3. Investment timing has become more strategic.
4. Risk premium adjustments show significant market revaluation.

FISCAL POLICY IMPLICATIONS

Key Findings:

Government expenditure patterns show significant changes:

Ukraine's expenditure coefficient increased from 14.05452 to 38.107

Russia's coefficient decreased from 9.03227 to 4.326199

Inferences:

1. Fiscal policy has become more important in Ukraine's economic management.
2. Russia shows signs of fiscal constraint.
3. Automatic stabilizers show varying effectiveness.
4. International aid dependency has increased for Ukraine.

DEMOGRAPHIC AND SOCIAL IMPACT

Key Findings:

Population movement patterns show significant changes:

Ukraine's urban growth variance increased from 0.105399047 to 17.23182322

Russia's remained relatively stable (0.062006894 to 0.044593667).

Inferences:

1. Conflict has triggered significant population movements in Ukraine.
2. Urban centres show varying degrees of resilience.
3. Network migration patterns have emerged.
4. Return migration potential varies significantly.

MARKET STRUCTURE TRANSFORMATIONS

Key Findings:

Manufacturing value-added variance shows significant changes:

Ukraine: 47.41061831 → 2.475296647

Russia: 8.12276E+20 → 0.497963466

Inferences:

1. Industrial organization has undergone fundamental changes.
2. Market concentration patterns have shifted.
3. Value chains show significant disruption.
4. Scale economies have been affected.

FINANCIAL MARKET RESULTS

Key Findings:

Exchange rate dynamics show increased volatility:

Ukraine: 6.408799432 → 67.42827921

Russia: 2.16235E+20 → 233.2091404

Inferences:

1. Currency markets show increased instability.
2. Policy response effectiveness varies.
3. International reserves play crucial roles.
4. Speculative pressures have increased.

HYPOTHESIS ANALYSIS

T-test:

Null Hypothesis (H0): There is no significant difference between the means of GDP growth and inflation rates during war timeframes.

Alternative Hypothesis (H1): There is a significant difference between the means of GDP growth and inflation rates during war timeframes.

Result: If the p-value is less than 0.05, we reject the null hypothesis, indicating a significant difference between the two means. Otherwise, we fail to reject the null hypothesis.

F-test:

Null Hypothesis (H0): The variances of GDP growth and inflation rates during war timeframes are equal.

Alternative Hypothesis (H1): The variances of GDP growth and inflation rates during war timeframes are not equal.

Result: If the p-value is less than 0.05, we reject the null hypothesis, indicating a significant difference in variances. Otherwise, we fail to reject the null hypothesis.

Paired T-test:

Null Hypothesis (H0): There is no significant difference between the paired observations of GDP growth and inflation rates during war timeframes.

Alternative Hypothesis (H1): There is a significant difference between the paired observations of GDP growth and inflation rates during war timeframes.

Result: If the p-value is less than 0.05, we reject the null hypothesis, indicating a significant difference between the paired observations. Otherwise, we fail to reject the null hypothesis.

ANOVA:

Null Hypothesis (H0): All group means are equal during war timeframes.

Alternative Hypothesis (H1): At least one group mean is different during war timeframes.

Result: If the p-value is less than 0.05, we reject the null hypothesis, indicating that at least one group mean is different. Otherwise, we fail to reject the null hypothesis.

Chi-square Test:

Null Hypothesis (H0): There is no association between the categorical variables (Country and Indicator) during war timeframes.

Alternative Hypothesis (H1): There is an association between the categorical variables during war timeframes.

Result: If the p-value is less than 0.05, we reject the null hypothesis, indicating a significant association between the variables. Otherwise, we fail to reject the null hypothesis.

RANKING (BASIC LEVEL)

Objective:

The ranking method aims to highlight economic and demographic indicators most impacted by war by analysing changes over time in World Bank data. For war-affected countries, it identifies shifts in parameters like GDP, health, and education, reflecting the consequences of conflict. This approach seeks to uncover the areas most disrupted, providing valuable insights into the broader socio-economic toll of war and guiding recovery efforts.

Issues and ineffectiveness:

However, the method is flawed as it relies on absolute changes, ignoring proportional shifts and the relative scale of indicators. Comparing only two years overlooks trends, fluctuations, and context, leading to oversimplified conclusions. Additionally, missing data, a common issue in conflict zones, can skew results, and the lack of normalization or benchmarking against global trends makes the rankings less meaningful.

Improvements in the future:

To improve, normalize data using percentage changes or z-scores and analyse trends over the entire period using time-series models. Address missing data with imputation methods and compare changes to global or regional averages for context. Advanced techniques like Principal Component Analysis (PCA) or weighted scoring systems can provide more robust rankings, offering deeper insights into the consequences of war.

OBSERVATION SUMMARY

The war caused considerable disruptions in economic, social, and fiscal dimensions for both countries. Ukraine experienced significant structural changes, reflected in reduced GDP variance and tighter monetary control, while Russia grappled with inflationary pressures and fiscal constraints. Labor market transformations in Ukraine were severe, with a breakdown in traditional employment-output relationships, whereas Russia showed resilience but faced potential rigidities.

International trade integration decreased for both countries, reflecting trade reorientation and reduced global interdependence. Foreign direct investment (FDI) patterns diverged, with Ukraine stabilizing its FDI variance while Russia faced increased volatility due to heightened investment risks. Fiscal policies diverged sharply, with Ukraine leaning heavily on international aid while expanding government expenditure, and Russia showing signs of fiscal tightening.

Demographic changes were stark in Ukraine, with rapid urban migration and network migration patterns emerging as survival mechanisms. Market structures in both nations showed significant disruptions, with declines in manufacturing value-added metrics reflecting long-term industrial changes. Financial markets displayed heightened volatility in exchange rates, indicating prolonged economic instability.

INFERENCES

- The reduction in GDP variance for both countries indicate a shift toward more rigid and controlled economic patterns. Ukraine's transition from market-driven structures to command-like mechanisms allowed for resource reallocation to prioritize war-related activities, leading to the development of parallel economic structures for survival. The coefficient of variation analysis further highlights how both nations adjusted their economic models to adapt to prolonged conflict.

- Price stability and inflation trends revealed divergent policy responses. Ukraine's dramatic reduction in inflation variance reflects successful monetary controls during war conditions, showcasing the effectiveness of its crisis management strategies. In contrast, Russia faced increased inflation volatility, highlighting structural economic challenges and monetary instability. ARCH/GARCH modelling demonstrated the persistence of inflation during the conflict, further emphasizing the difficulty of achieving economic stability.

- Labor market dynamics underscored the transformative impact of the war. Ukraine's labor market experienced a decoupling from traditional GDP-output relationships, signalling a shift in workforce composition and employment patterns. Meanwhile, Russia's stable but rigid labor market correlation suggests resilience in the face of conflict but with long-term risks of stagnation. Youth employment challenges in both nations indicate potential long-term structural hurdles.

- International trade integration declined sharply for both countries, with trade-to-GDP variation coefficients decreasing as they sought to reorient trade relationships. Panel data analysis confirmed structural trade changes and the significant, likely long-lasting impact of trade diversion. Both economies became less globally integrated, a trend that reflects the fragmentation of international partnerships.

- FDI patterns reflected heightened risk perception, with Ukraine experiencing a stabilization in FDI variance due to geographic diversification and strategic investment timing. Conversely, Russia faced increasing FDI volatility, reflecting heightened risks associated with sanctions and geopolitical isolation. These shifts indicate significant market revaluation and increased premiums for conflict-zone investments.

- Fiscal policy responses highlighted divergent strategies. Ukraine's increased government expenditure coefficient indicates reliance on fiscal measures to stabilize the economy and manage crisis impacts. Heavy dependence on international aid was a critical factor in maintaining economic balance. In contrast, Russia showed fiscal constraint, reflecting limited fiscal flexibility and a focus on maintaining stability amid sanctions and declining revenues.

- Demographic and social impacts were profound, particularly for Ukraine, which saw significant population movements, including urban migration and the emergence of network migration patterns. These changes have implications for urban resilience and potential return migration in post-conflict reconstruction. Russia's demographic patterns remained relatively stable, although long-term impacts on population composition are likely.

- Market structures were fundamentally disrupted in both countries, with manufacturing value-added metrics showing sharp declines. These changes reflect the reorganization of industrial systems, disruptions in value chains, and adverse effects on economies of scale. Financial markets exhibited increased exchange rate volatility, underscoring the difficulties in stabilizing currency markets during protracted conflict.

CONCLUSION

The analysis highlights the profound short-term, medium-term, and long-term economic impacts of the Russia-Ukraine war. In the short term, both economies underwent significant restructuring, with the emergence of parallel structures and greater state intervention to manage disruptions. Ukraine demonstrated effective crisis management through tighter monetary controls, while Russia faced structural monetary challenges.

In the medium term, labor market transformations and trade reorientation emerged as critical challenges. Ukraine experienced significant employment disruptions and fiscal policy strain, while Russia faced reduced trade integration and increasing fiscal constraints. The reorganization of investment patterns further reflected heightened risk perception in both economies.

Over the long term, the conflict has triggered demographic shifts, market structure transformations, and changes in international economic relationships. Ukraine's rapid urban migration and manufacturing disruption highlight the social and economic scars of war. Russia's reduced manufacturing metrics and increased financial volatility underscore the enduring challenges of geopolitical isolation.

To address these impacts, immediate actions should focus on strengthening crisis management frameworks, maintaining financial stability, and enhancing humanitarian support. Medium-term strategies must prioritize economic reconstruction, institutional rebuilding, and human capital development. Long-term plans should aim for sustainable development, regional integration, and the establishment of resilient economic frameworks to ensure stability and growth.

The findings underline the need for coordinated national and international efforts to rebuild and reimagine the economic and social structures of both nations, offering valuable insights for future conflict economics and policy development.

REFERENCES AND LINKS

World Bank dataset source: https://data.worldbank.org/about/get-started

GitHub Link (Contains all codes, presentation slides, datasets and the documents) :

https://github.com/gautham-here/consequences-of-war-using-R

CODES AND OUTPUT TABULATIONS

Code A: Imputation of original data

```
#library(readxl)
dataA <- read_excel("dataA.xlsx")
View(init)

library(dplyr)

# Mean imputation for all numeric columns
data_imputed <- dataA %>%
  mutate(across(where(is.numeric), ~ ifelse(is.na(.), mean(., na.rm = TRUE), .)))

# Check to ensure imputation was successful
summary(data_imputed)

# Install writexl if you haven't already
install.packages("writexl")

# Load the necessary library
library(writexl)

# Save the imputed data to an Excel file
write_xlsx(data_imputed, "imputedA.xlsx")

# Display the imputed data
data_imputed
```

Code B1: Variance Calculation

```
# Define the countries and year ranges for analysis
country_codes <- c("UKR", "RUS")  # Example: Ukraine and Russia
year_ranges <- list(
  "1993-2013" = 1993:2013,
  "2013-2023" = 2013:2023
)

# Initialize an empty list to accumulate data for each indicator
variance_list <- list()

# Loop over each country and year range
for (country in country_codes) {
  for (year_range_name in names(year_ranges)) {
    # Define the years for the current range
    years <- year_ranges[[year_range_name]]

    # Extract data for the specific country from the imputed dataset
    country_data <- imputedA[imputedA$CountryCode == country, ]

    # Loop over each indicator in the country dataset
    for (i in 1:nrow(country_data)) {
      # Get the parameter name (using only Indicator since IndicatorCode is unavailable)
      param_name <- country_data$Indicator[i]

      # Extract data for the parameter across the specified years
      data_values <- as.numeric(country_data[i, as.character(years)])

      # Calculate the variance for this parameter
      variance_value <- var(data_values, na.rm = TRUE)

      # Define a unique column name for each country and year range combination
      column_name <- paste(country, "(", year_range_name, ")", sep = "")

      # Check if the indicator already exists in the list, if not, initialize it
      if (!param_name %in% names(variance_list)) {
        variance_list[[param_name]] <- data.frame(Indicator = param_name)
```

```
    }

    # Add the variance value to the corresponding column
    variance_list[[param_name]][[column_name]] <- variance_value
   }
  }
}

# Convert the list to a data frame
variance_table <- do.call(rbind, variance_list)
variance_table <- as.data.frame(variance_table, stringsAsFactors = FALSE)

# Install and load the writexl package (if not already installed)
if (!require("writexl")) install.packages("writexl")
library(writexl)

# Save the variance_table as an Excel file
write_xlsx(variance_table, "Country_Variances_by_Year.xlsx")
```

Table B1: Variance – UKR and RUS

Indicator	UKR(1993-2013)	UKR(2013-2023)	RUS(1993-2013)	RUS(2013-2023)
Adjusted net savings, excluding particulate emission damage (% of GNI)	1.63618E+20	2.04531E+22	7.97864E+19	2.04531E+22
Age dependency ratio (% of working-age population)	12.21973599	12.93685727	17.93683	11.31092077
Agricultural raw materials exports (% of merchandise exports)	2.77057E+20	0.07972774	2.77057E+20	2.04531E+22
Central government debt, total (% of GDP)	6.10663E+20	2.34918E+22	1.30061E+21	1.30071E+22
Current account balance (% of GDP)	7.97864E+19	20.05075313	7.97864E+19	8.032515212
Employment to population ratio, 15+, total (%) (national estimate)	1.5452E+21	2.04531E+22	10.34701375	8.437961673
Exports of goods and services (current US$)	6.61629E+20	1.42095E+20	3.46621E+22	9.35152E+21
External debt stocks, short-term (DOD, current US$)	639.9276111	1.30071E+22	281.464747	1.30071E+22
External health expenditure (% of current health expenditure)	6.61171E+20	2.43625E+22	2.32579E+23	9.72742E+23
Foreign direct investment, net (BoP, current US$)	1.04546E+20	6.86408E+18	1.36846E+20	2.37305E+20
GDP (current US$)	3.26052E+21	1.37006E+21	4.85961E+23	1.21297E+23
GDP growth (annual %)	88.51263928	101.8556504	41.39994775	6.62375324
GDP per capita (current US$)	1640061.457	1092161.113	23940683.8	5993186.778

General government final consumption expenditure (% of GDP)	7.297896556	77.35570529	2.665725973	0.616871798
GNI (current US$)	3.03777E+21	1.30999E+21	4.5414E+23	1.15174E+23
Government expenditure on education, total (% of GDP)	4.29419E+20	1.30071E+22	1.38015E+22	2.34918E+22
Gross fixed capital formation (% of GDP)	7.511582434	4.186382864	4.912587177	0.754097198
Gross savings (% of GDP)	7.97864E+19	17.84223356	7.97864E+19	6.763639194
High-technology exports (% of manufactured exports)	6.4627E+22	1.30071E+22	1.32648E+22	2.04531E+22
Imports of goods and services (current US$)	9.56191E+20	2.24225E+20	1.90362E+22	3.60382E+21
Inflation, consumer prices (annual %)	1074317.66	164.5308392	38483.13135	2.04531E+22
Labor force participation rate for ages 15-24, total (%) (national estimate)	2.20294E+23	3.12173E+23	17.14069043	14.63062467
Labor force participation rate, total (% of total population ages 15+) (national estimate)	4.64626E+20	2.04531E+22	4.156374562	11.13296105
Manufacturing, value added (% of GDP)	47.41061831	2.475296647	8.12276E+20	0.497963466
Merchandise exports (current US$)	4.68668E+20	1.12341E+20	3.01484E+22	8.86492E+21
Merchandise imports (current US$)	7.502E+20	1.46275E+20	1.18917E+22	2.30894E+21
Military expenditure (% of GDP)	0.233654765	1.30071E+22	0.175076335	1.30071E+22
Net barter terms of trade index (2015 = 100)	6.61171E+20	2.04531E+22	6.61171E+20	2.04531E+22
Net foreign assets (current LCU)	1.58236E+21	3.71176E+23	4.78851E+25	3.20929E+26
Official exchange rate (LCU per US$, period average)	6.408799432	67.42827921	2.16235E+20	233.2091404
Population growth (annual %)	0.088978467	17.44057298	0.053291348	0.070223462
Population, total	5.12445E+12	8.9625E+12	5.09687E+12	3.7977E+11
Refugee population by country or territory of asylum	7.97864E+19	190229.1636	2.77056E+20	2.21982E+11
Refugee population by country or territory of origin	1012709729	5.31846E+12	3918864111	89885087.36
Revenue, excluding grants (% of GDP)	6.10663E+20	1.30071E+22	8.12276E+20	1.30071E+22
Rural population growth (annual %)	0.104488623	17.96691622	0.043365496	0.19513288
Services, value added (% of GDP)	47.64364778	16.67797947	9.684941901	1.384958566
Tariff rate, applied, weighted mean, all products (%)	7.17769E+21	2.04531E+22	1.18882E+22	2.04531E+22
Tax revenue (% of GDP)	6.10663E+20	1.30071E+22	8.12276E+20	1.30071E+22
Total reserves minus gold (current US$)	1.5685E+20	8.07982E+19	4.04701E+22	4.21641E+21
Trade (% of GDP)	176.2287547	115.0426029	51.9414849	8.461311331
Unemployment, female (% of female labor force) (national estimate)	6.2501E+22	2.04531E+22	5.415633757	0.497193055
Unemployment, male (% of male labor force) (national estimate)	6.2501E+22	2.04531E+22	5.261391829	0.876158855

Unemployment, total (% of total labor force) (national estimate)	1.63618E+20	2.04531E+22	5.333147233	0.666182764
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)	7.9746E+22	2.11559E+22	13.82473786	3.597873473
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)	7.9746E+22	2.11559E+22	12.27171753	2.812748873
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)	7.9746E+22	2.11559E+22	12.7782104	3.107233255
Urban population (% of total population)	0.502134648	0.159107364	0.027694262	0.241427273
Urban population growth (annual %)	0.105399047	17.23182322	0.062006894	0.044593667

Code B2: Coefficient of Variation – UKR and RUS

```
# # Define the countries and year ranges for analysis
country_codes <- c("UKR", "RUS")  # Example: Ukraine and Russia
year_ranges <- list(
  "1993-2013" = 1993:2013,
  "2013-2023" = 2013:2023
)

# Initialize an empty list to accumulate data for each indicator
cv_list <- list()

# Loop over each country and year range
for (country in country_codes) {
  for (year_range_name in names(year_ranges)) {
    # Define the years for the current range
    years <- year_ranges[[year_range_name]]

    # Extract data for the specific country from the imputed dataset
    country_data <- imputedA[imputedA$CountryCode == country, ]

    # Loop over each indicator in the country dataset
    for (i in 1:nrow(country_data)) {
      # Get the parameter name (using only Indicator since IndicatorCode is unavailable)
      param_name <- country_data$Indicator[i]

      # Extract data for the parameter across the specified years
      data_values <- as.numeric(country_data[i, as.character(years)])

      # Calculate the mean and variance for this parameter
```

```
    mean_value <- mean(data_values, na.rm = TRUE)
    variance_value <- var(data_values, na.rm = TRUE)

    # Calculate the Coefficient of Variation (CV)
    cv_value <- (sqrt(variance_value) / abs(mean_value)) * 100  # Use absolute mean for positive CV

    # Define a unique column name for each country and year range combination
    column_name <- paste(country, "(", year_range_name, ")", sep = "")

    # Check if the indicator already exists in the list, if not, initialize it
    if (!param_name %in% names(cv_list)) {
      cv_list[[param_name]] <- data.frame(Indicator = param_name)
    }

    # Add the CV value to the corresponding column
    cv_list[[param_name]][[column_name]] <- cv_value
  }
 }
}

# Convert the list to a data frame
cv_table <- do.call(rbind, cv_list)
cv_table <- as.data.frame(cv_table, stringsAsFactors = FALSE)

# Install and load the writexl package (if not already installed)
if (!require("writexl")) install.packages("writexl")
library(writexl)

# Save the CV table as an Excel file
write_xlsx(cv_table, "Country_CV_by_Year.xlsx")
```

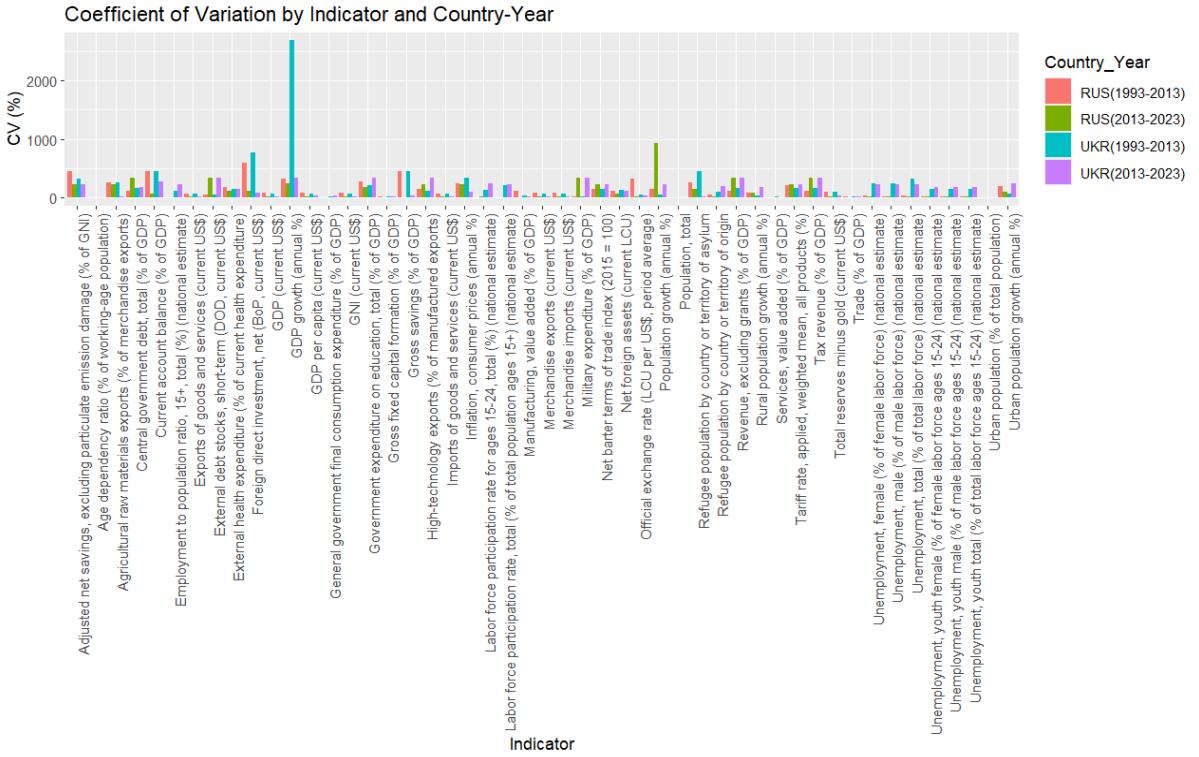
Table B2: Coefficient of Variation – UKR and RUS

Indicator	UKR(1993-2013)	UKR(2013-2023)	RUS(1993-2013)	RUS(2013-2023)
Adjusted net savings, excluding particulate emission damage (% of GNI)	316.0676	223.2179	458.2576	223.2179
Age dependency ratio (% of working-age population)	7.612717	7.574298	9.741069	7.185206
Agricultural raw materials exports (% of merchandise exports)	252.8734	15.32838	252.8734	223.2179

Central government debt, total (% of GDP)	164.7598	173.6005	121.1814	331.6625
Current account balance (% of GDP)	458.2576	268.698	458.2576	67.54244
Employment to population ratio, 15+, total (%) (national estimate)	112.4032	223.2179	5.318702	4.7142
Exports of goods and services (current US$)	62.43634	19.63827	70.6968	20.04677
External debt stocks, short-term (DOD, current US$)	50.51805	331.6625	43.13769	331.6625
External health expenditure (% of current health expenditure)	147.1755	142.3456	186.8572	114.8358
Foreign direct investment, net (BoP, current US$)	764.2944	85.01276	590.7453	114.9977
GDP (current US$)	62.69547	25.40946	79.42709	19.60568
GDP growth (annual %)	2688.826	346.023	316.1252	235.2392
GDP per capita (current US$)	66.25841	29.22289	80.27496	20.22486
General government final consumption expenditure (% of GDP)	14.05452	38.107	9.03227	4.326199
GNI (current US$)	62.77161	24.58707	78.94099	19.61518
Government expenditure on education, total (% of GDP)	215.2962	331.6625	270.8495	173.6005
Gross fixed capital formation (% of GDP)	12.99421	13.49051	11.33711	4.109983
Gross savings (% of GDP)	458.2576	30.31475	458.2576	9.56225
High-technology exports (% of manufactured exports)	121.2488	331.6625	139.1598	223.2179
Imports of goods and services (current US$)	69.74301	20.62701	72.57254	17.06395
Inflation, consumer prices (annual %)	346.5014	92.31005	239.2078	223.2179
Labor force participation rate for ages 15-24, total (%) (national estimate)	131.4657	239.3317	9.68618	11.06401
Labor force participation rate, total (% of total population ages 15+) (national estimate)	215.9732	223.2179	3.093054	5.14864
Manufacturing, value added (% of GDP)	34.42416	14.66283	120.6884	5.722334
Merchandise exports (current US$)	67.84782	21.96414	75.89317	22.02562
Merchandise imports (current US$)	74.36245	21.40315	77.21194	18.23162
Military expenditure (% of GDP)	24.51956	331.6625	11.71522	331.6625
Net barter terms of trade index (2015 = 100)	147.1755	223.2179	147.1755	223.2179
Net foreign assets (current LCU)	134.3166	108.8795	117.2692	61.30584
Official exchange rate (LCU per US$, period average)	53.65732	33.44446	317.3847	24.58179
Population growth (annual %)	45.84178	219.9639	149.7192	935.0271
Population, total	4.689279	6.88836	1.554047	0.425831
Refugee population by country or territory of asylum	458.2566	15.78651	252.8717	145.2763
Refugee population by country or territory of origin	102.0647	198.1382	49.96786	13.9509
Revenue, excluding grants (% of GDP)	164.7598	331.6625	120.6884	331.6625
Rural population growth (annual %)	33.91875	185.1618	86.59214	84.5978
Services, value added (% of GDP)	14.64742	7.494323	6.094408	2.11866
Tariff rate, applied, weighted mean, all products (%)	165.2586	223.2179	217.5315	223.2179

Tax revenue (% of GDP)	164.7598	331.6625	120.6884	331.6625
Total reserves minus gold (current US$)	98.57569	41.79236	106.1515	15.97613
Trade (% of GDP)	14.19254	11.46456	13.08627	6.166313
Unemployment, female (% of female labor force) (national estimate)	239.0739	223.2179	29.12372	14.75033
Unemployment, male (% of male labor force) (national estimate)	239.0739	223.2179	26.69394	18.69586
Unemployment, total (% of total labor force) (national estimate)	316.0676	223.2179	27.82251	16.66797
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)	147.1257	180.1907	19.98532	11.77084
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)	147.1257	180.1907	20.62207	11.48995
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)	147.1257	180.1907	20.18329	11.55162
Urban population (% of total population)	1.047038	0.574678	0.226455	0.659546
Urban population growth (annual %)	63.96745	240.4112	202.0027	97.71353

Plot B2: Coefficient of Variation – UKR and RUS



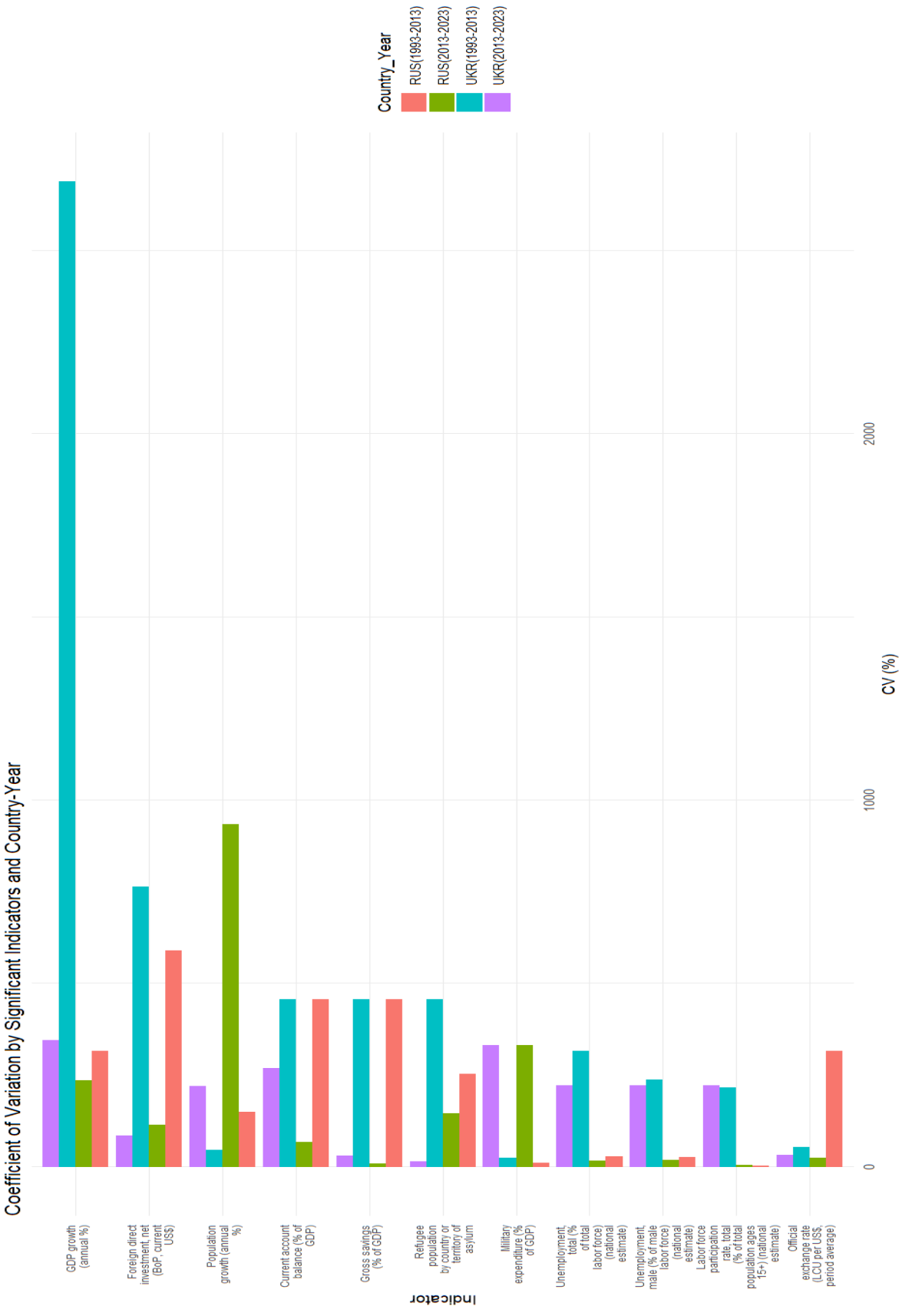

Coefficient of Variation by Significant Indicators and Country-Year
Country_Year
RUS(1993-2013)
RUS(2013-2023)
UKR(1993-2013)
UKR(2013-2023)
CV (%)
0
1000
2000
Indicator
GDP growth (annual %)
Foreign direct investment, net (BoP, current US$)
Population growth (annual %)
Current account balance (% of GDP)
Gross savings (% of GDP)
Refugee population by country or territory of asylum
Military expenditure (% of GDP)
Unemployment, total (% of total labor force) (national estimate)
Unemployment, male (% of male labor force) (national estimate)
Labor force participation rate, total (% of total population ages 15+) (national estimate)
Official exchange rate (LCU per US$, period average)

Table B2 (a) : Coefficient of Variation – IND and PAK

Indicator	IND(1990-1999)	IND(2000-2007)	IND(2008-2023)	PAK(1990-1999)	PAK(2000-2007)	PAK(2008-2023)
Adjusted net savings, excluding particulate emission damage (% of GNI)	16.18266	19.54048	274.0927	27.52907	16.17042	274.0927
Age dependency ratio (% of working-age population)	3.021774	3.497406	6.846424	1.503619	3.366022	3.498653
Agricultural raw materials exports (% of merchandise exports)	42.26245	24.78389	45.19418	316.2278	33.02523	35.11763
Central government debt, total (% of GDP)	3.658986	4.67378	157.6635	107.1092	82.19972	87.30291
Current account balance (% of GDP)	44.6743	1266.419	76.9044	40.57792	915.4244	86.75711
Employment to population ratio, 15+, total (%) (national estimate)	39.72992	105.1799	133.5187	212.2219	198.355	187.4636
Exports of goods and services (current US$)	30.18372	55.30283	29.32389	16.35539	30.6243	13.63451
External debt stocks, short-term (DOD, current US$)	15.16608	12.88639	400	4.549714	17.84004	400
External health expenditure (% of current health expenditure)	17.2754	25.99659	274.0927	17.2754	51.32411	274.0927
Foreign direct investment, net (BoP, current US$)	85.35608	40.77913	38.64515	45.28813	105.6966	56.02241
GDP (current US$)	18.77674	36.29151	30.30615	15.31551	25.45153	21.05631
GDP growth (annual %)	37.97736	30.18004	59.67034	48.11947	34.65794	63.77522
GDP per capita (current US$)	13.46428	32.23393	25.38378	8.32624	19.9841	15.03207
General government final consumption expenditure (% of GDP)	5.414363	7.617552	3.627492	11.2159	8.800827	5.066145
GNI (current US$)	19.05979	36.45518	30.15304	15.02712	25.60768	21.15214
Government expenditure on education, total (% of GDP)	72.37209	209.5485	225.9889	316.2278	145.6651	274.0927
Gross fixed capital formation (% of GDP)	4.748246	10.47785	7.965114	9.140523	7.659554	8.279749
Gross savings (% of GDP)	9.005295	13.92787	7.870786	11.84114	9.800674	11.14066
High-technology exports (% of manufactured exports)	17.2754	75.21818	282.4126	17.2754	75.21818	400
Imports of goods and services (current US$)	33.75025	60.20101	27.39742	16.43808	48.46924	21.88792
Inflation, consumer prices (annual %)	30.9783	22.29037	38.67317	27.70502	44.21434	65.37999
Labor force participation rate for ages 15-24, total (%) (national estimate)	55.95863	113.537	133.5187	212.2219	198.355	187.4636
Labor force participation rate, total (% of total population ages 15+) (national estimate)	55.95863	113.537	133.5187	212.2219	198.355	187.4636
Manufacturing, value added (% of GDP)	5.319841	4.287998	8.866387	3.375879	13.81473	7.225654
Merchandise exports (current US$)	27.25124	49.85543	25.40364	15.09616	27.33175	14.56081
Merchandise imports (current US$)	30.48057	60.73954	26.6116	15.40892	48.3325	22.18659
Military expenditure (% of GDP)	7.194671	5.795462	400	8.654642	5.794587	400
Net barter terms of trade index (2015 = 100)	10.37193	7.020948	274.0927	8.501538	21.02971	274.0927
Net foreign assets (current LCU)	83.60365	55.9408	102.1283	73.80515	66.10069	517.2142
Official exchange rate (LCU per US$, period average)	25.20512	4.796051	19.55079	28.31632	4.286584	43.62879
Population growth (annual %)	4.799848	7.930886	20.3848	7.858482	17.15243	19.73658
Population, total	5.997464	4.054723	5.417072	8.723628	5.612377	7.664354
Refugee population by country or territory of asylum	12.96429	6.266744	10.07435	49.65791	32.4959	11.92555

Refugee population by country or territory of origin	83.77099	21.08967	36.3038	72.41835	33.91657	76.66209
Revenue, excluding grants (% of GDP)	4.854983	8.856691	157.6635	72.37209	82.19972	87.30291
Rural population growth (annual %)	5.325349	15.18144	60.68252	8.943332	19.76438	24.76765
Services, value added (% of GDP)	3.86915	1.444795	3.217227	2.428514	2.12399	2.398712
Tariff rate, applied, weighted mean, all products (%)	106.8607	33.76942	298.067	73.21827	25.55274	225.0435
Tax revenue (% of GDP)	7.228432	13.95879	157.6635	72.37209	82.19972	87.30291
Total reserves minus gold (current US$)	64.96962	63.69328	32.23535	64.43769	48.04766	35.55264
Trade (% of GDP)	14.71684	23.3064	12.59014	5.480051	15.94711	10.25026
Unemployment, female (% of female labor force) (national estimate)	39.72992	105.1799	133.5187	38.93623	61.58682	187.4636
Unemployment, male (% of male labor force) (national estimate)	39.72992	105.1799	133.5187	10.96418	54.87357	187.4636
Unemployment, total (% of total labor force) (national estimate)	39.72992	105.1799	133.5187	23.94507	56.56273	187.4636
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)	39.72992	105.1799	133.5187	212.2219	173.9267	187.4636
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)	39.72992	105.1799	133.5187	212.2219	173.9267	187.4636
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)	39.72992	105.1799	133.5187	212.2219	173.9267	187.4636
Urban population (% of total population)	2.402008	2.763287	5.85735	2.377914	1.459856	2.953249
Urban population growth (annual %)	5.19448	4.613437	6.347308	6.717488	13.89509	15.61174

Table B2 (b) : Coefficient of Variation – Russia and USA

Indicator	**RUS(1997-2010)**	**RUS(2010-2023)**	**USA(1997-2010)**	**USA(2010-2023)**
Adjusted net savings, excluding particulate emission damage (% of GNI)	490.985	254.9939	46.81716	254.9939
Age dependency ratio (% of working-age population)	7.368187	9.68375	2.244114	3.499674
Agricultural raw materials exports (% of merchandise exports)	17.6136	254.9939	7.037038	11.52283
Central government debt, total (% of GDP)	134.0408	374.1657	25.31917	374.1657
Current account balance (% of GDP)	62.44242	59.90171	33.3129	25.28139
Employment to population ratio, 15+, total (%) (national estimate)	5.177005	4.421021	2.77978	1.852214
Exports of goods and services (current US$)	63.39983	18.92759	26.13306	26.68512
External debt stocks, short-term (DOD, current US$)	43.47257	374.1657	89.83611	90.64571
External health expenditure (% of current health expenditure)	225.6959	102.103	199.4139	254.9939
Foreign direct investment, net (BoP, current US$)	431.0416	118.478	429.6665	1308.816
GDP (current US$)	69.66602	18.91263	18.7552	18.83422
GDP growth (annual %)	115.8561	148.3453	79.5177	71.71119
GDP per capita (current US$)	70.56624	19.57215	14.9607	16.31879
General government final consumption expenditure (% of GDP)	10.24863	3.9883	6.041474	374.1657
GNI (current US$)	69.55441	18.89324	18.60497	18.43472

Government expenditure on education, total (% of GDP)	284.2152	201.2182	129.3873	374.1657
Gross fixed capital formation (% of GDP)	12.19687	3.680662	6.781309	374.1657
Gross savings (% of GDP)	16.61974	8.569376	12.8765	374.1657
High-technology exports (% of manufactured exports)	121.2717	254.9939	121.2717	374.1657
Imports of goods and services (current US$)	65.76254	16.87755	28.78609	28.34352
Inflation, consumer prices (annual %)	101.0082	254.9939	44.66801	76.9913
Labor force participation rate for ages 15-24, total (%) (national estimate)	4.671654	12.02901	5.631732	0.978817
Labor force participation rate, total (% of total population ages 15+) (national estimate)	2.959558	4.992633	1.085771	1.320776
Manufacturing, value added (% of GDP)	140.2319	5.854594	10.54617	254.9939
Merchandise exports (current US$)	63.90013	20.6016	25.06817	13.3887
Merchandise imports (current US$)	67.4426	17.99523	28.51571	15.23349
Military expenditure (% of GDP)	10.52857	374.1657	16.3801	374.1657
Net barter terms of trade index (2015 = 100)	199.4139	254.9939	4.023292	254.9939
Net foreign assets (current LCU)	109.337	62.67258	150.8211	567.3263
Official exchange rate (LCU per US$, period average)	30.92355	34.5259	0	0
Population growth (annual %)	69.0994	463.8209	12.21649	33.17056
Population, total	1.354279	0.615148	4.004938	2.608462
Refugee population by country or territory of asylum	178.3267	170.1984	34.57153	15.43086
Refugee population by country or territory of origin	46.28447	25.98372	106.9495	92.10211
Revenue, excluding grants (% of GDP)	140.2319	374.1657	12.92923	374.1657
Rural population growth (annual %)	48.84122	103.8485	286.4908	69.78608
Services, value added (% of GDP)	3.303087	2.354042	1.816916	254.9939
Tariff rate, applied, weighted mean, all products (%)	180.7281	254.9939	21.73288	254.9939
Tax revenue (% of GDP)	140.2319	374.1657	14.1481	374.1657
Total reserves minus gold (current US$)	101.77	14.87093	30.84079	33.85818
Trade (% of GDP)	11.63068	5.675725	9.592719	374.1657
Unemployment, female (% of female labor force) (national estimate)	28.65104	17.6045	24.67506	34.28003
Unemployment, male (% of male labor force) (national estimate)	25.91944	22.61754	35.72985	37.23575
Unemployment, total (% of total labor force) (national estimate)	27.2037	20.15303	30.71248	35.68709
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)	20.28336	10.66604	18.56528	31.1922
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)	21.93735	10.77957	25.45726	30.6958
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)	20.99984	10.59158	22.32468	30.77786
Urban population (% of total population)	0.166128	0.726164	1.053937	0.993522
Urban population growth (annual %)	84.8698	89.16809	18.1605	23.03322

Table B2 (c): Coefficient of Variation – Syria and Iran

Indicator	SYR(1999-2007)	SYR(2007-2015)	SYR(2015-2023)	IRN(1999-2007)	IRN(2007-2015)	IRN(2015-2023)
Adjusted net savings, excluding particulate emission damage (% of GNI)	300	199.4139	100.3057	94.28081	100.8994	90.64571
Age dependency ratio (% of working-age population)	6.203119	8.866498	13.46496	16.21104	23.35701	7.360502
Agricultural raw materials exports (% of merchandise exports)	300	199.4139	100.3057	300	201.2327	226.3723
Central government debt, total (% of GDP)	82.1983	89.83611	90.64571	82.1983	89.83611	90.64571
Current account balance (% of GDP)	66.91145	109.8131	100.3057	94.28081	100.8994	90.64571
Employment to population ratio, 15+, total (%) (national estimate)	199.0075	231.9195	100.3057	111.5464	129.3873	374.1657
Exports of goods and services (current US$)	36.26307	49.75076	232.7317	58.47167	66.2713	28.21988
External debt stocks, short-term (DOD, current US$)	82.1983	115.9162	254.9939	19.75671	32.34601	374.1657
External health expenditure (% of current health expenditure)	300	199.4139	124.3833	300	199.4139	254.9939
Foreign direct investment, net (BoP, current US$)	91.16255	113.2309	100.3314	94.28936	100.9073	90.64571
GDP (current US$)	31.59153	52.30421	163.108	44.33701	58.57894	26.30992
GDP growth (annual %)	97.57078	69.3421	254.9939	48.22145	68.06012	176.9214
GDP per capita (current US$)	22.29947	38.48025	254.9939	40.32726	52.87939	31.17145
General government final consumption expenditure (% of GDP)	11.47226	10.62485	254.9939	8.909675	9.055135	10.99125
GNI (current US$)	33.09799	53.87482	166.1248	44.34539	58.59731	26.44179
Government expenditure on education, total (% of GDP)	213.2238	223.2166	90.64571	4.592977	255.049	258.6198
Gross fixed capital formation (% of GDP)	9.252433	9.702906	254.9939	8.69465	7.881193	10.43454
Gross savings (% of GDP)	15.95268	21.70771	100.3057	94.28081	100.8994	90.64571
High-technology exports (% of manufactured exports)	82.1983	115.9162	100.3057	82.1983	89.83611	182.4257
Imports of goods and services (current US$)	40.97809	53.8833	213.832	46.10255	58.28302	19.95038
Inflation, consumer prices (annual %)	159.5913	143.6146	124.3833	20.76639	26.64821	53.71519
Labor force participation rate for ages 15-24, total (%) (national estimate)	199.0075	215.6889	90.64571	111.5464	129.3873	374.1657
Labor force participation rate, total (% of total population ages 15+) (national estimate)	199.0075	254.8654	111.2526	111.5464	129.3873	374.1657
Manufacturing, value added (% of GDP)	82.1983	89.83611	90.64571	8.311317	10.98586	374.1657
Merchandise exports (current US$)	39.02645	49.57194	78.13672	54.33907	64.99446	24.13443
Merchandise imports (current US$)	53.52529	61.23035	53.03386	44.88588	55.64533	16.82612
Military expenditure (% of GDP)	12.74508	17.00378	100.3057	14.4418	12.14569	374.1657
Net barter terms of trade index (2015 = 100)	300	199.4139	254.9939	300	199.4139	254.9939

Net foreign assets (current LCU)	22.78291	29.74114	94.63855	107.3717	108.3275	124.7203
Official exchange rate (LCU per US$, period average)	0	0	374.1657	55.11137	57.38938	42.06356
Population growth (annual %)	41.21517	38.915	820.898	20.16654	16.24936	36.41341
Population, total	8.68545	13.35521	7.232009	3.84058	5.972325	5.781745
Refugee population by country or territory of asylum	81.17525	71.95757	39.75108	32.13537	32.34005	74.22986
Refugee population by country or territory of origin	48.11273	42.71687	58.10667	20.7726	22.58824	27.91608
Revenue, excluding grants (% of GDP)	82.1983	89.83611	90.64571	13.90671	374.1657	90.64571
Rural population growth (annual %)	53.97391	52.46087	3437.451	51.25561	42.76742	71.72179
Services, value added (% of GDP)	4.499624	5.02601	254.9939	4.475675	5.493446	6.225053
Tariff rate, applied, weighted mean, all products (%)	92.67804	115.015	119.9934	146.6631	147.384	108.5519
Tax revenue (% of GDP)	82.1983	89.83611	90.64571	16.91223	374.1657	90.64571
Total reserves minus gold (current US$)	146.5073	118.0249	99.96728	82.1983	89.83611	90.64571
Trade (% of GDP)	9.364673	9.765777	254.9939	14.16012	17.75147	12.17834
Unemployment, female (% of female labor force) (national estimate)	175.4898	189.7715	100.3057	133.8195	134.0408	374.1657
Unemployment, male (% of male labor force) (national estimate)	175.4898	189.7715	100.3057	133.8195	134.0408	374.1657
Unemployment, total (% of total labor force) (national estimate)	175.4898	189.7715	100.3057	133.8195	134.0408	374.1657
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)	122.4094	149.563	100.3057	111.5464	129.3873	374.1657
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)	122.4094	149.563	100.3057	111.5464	129.3873	374.1657
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)	122.4094	149.563	100.3057	111.5464	129.3873	374.1657
Urban population (% of total population)	1.892951	2.877928	3.280614	2.883275	4.286822	2.883698
Urban population growth (annual %)	33.59889	31.44227	638.6588	12.17593	11.54244	26.084

Code C: Covariance and Correlation

```
# Load required library
if (!require(openxlsx)) install.packages("openxlsx", dependencies = TRUE)
library(openxlsx)

# Define country and indicators
country_code <- "UKR"
indicator1_name <- "GDP growth (annual %)"  # Name of the GDP growth indicator
indicator2_name <- "Inflation, consumer prices (annual %)"  # Name of the inflation indicator
```

```
# Define years for pre-war and war periods
pre_war_years <- as.character(2004:2013)
war_years <- as.character(2014:2023)

# Filter data for the specified country and indicators
country_data <- dataA[dataA$CountryCode == country_code, ]
indicator_data_1 <- country_data[country_data$Indicator == indicator1_name, pre_war_years]
indicator_data_2 <- country_data[country_data$Indicator == indicator2_name, pre_war_years]

# Convert the data to vectors for pre-war period
pre_war_data_1 <- as.numeric(unlist(indicator_data_1))
pre_war_data_2 <- as.numeric(unlist(indicator_data_2))

indicator_data_1_war <- country_data[country_data$Indicator == indicator1_name, war_years]
indicator_data_2_war <- country_data[country_data$Indicator == indicator2_name, war_years]
war_data_1 <- as.numeric(unlist(indicator_data_1_war))
war_data_2 <- as.numeric(unlist(indicator_data_2_war))

# Ensure vectors are aligned correctly by checking length equality
if (length(pre_war_data_1) == length(pre_war_data_2) && length(war_data_1) == length(war_data_2)) {

  # Calculate covariance and pairwise correlation for pre-war period
  pre_war_cov <- cov(pre_war_data_1, pre_war_data_2, use = "pairwise.complete.obs")
  pre_war_cor_pearson <- cor(pre_war_data_1, pre_war_data_2, method = "pearson", use = "pairwise.complete.obs")
  pre_war_cor_spearman <- cor(pre_war_data_1, pre_war_data_2, method = "spearman", use = "pairwise.complete.obs")
  pre_war_cor_kendall <- cor(pre_war_data_1, pre_war_data_2, method = "kendall", use = "pairwise.complete.obs")

  # Calculate covariance and pairwise correlation for war period
  war_cov <- cov(war_data_1, war_data_2, use = "pairwise.complete.obs")
  war_cor_pearson <- cor(war_data_1, war_data_2, method = "pearson", use = "pairwise.complete.obs")
```

```
 war_cor_spearman <- cor(war_data_1, war_data_2, method = "spearman", use = "pairwise.complete.obs")
 war_cor_kendall <- cor(war_data_1, war_data_2, method = "kendall", use = "pairwise.complete.obs")

 results <- data.frame(
  Period = c("Pre-War", "Pre-War", "Pre-War", "Pre-War", "War", "War", "War", "War"),
  Metric = c("Covariance", "Pearson Correlation", "Spearman Correlation", "Kendall Correlation",
          "Covariance", "Pearson Correlation", "Spearman Correlation", "Kendall Correlation"),
  Value = c(pre_war_cov, pre_war_cor_pearson, pre_war_cor_spearman, pre_war_cor_kendall,
          war_cov, war_cor_pearson, war_cor_spearman, war_cor_kendall)
 )
 write.xlsx(results, file = "correlation_results.xlsx", sheetName = "Pairwise Correlations", rowNames = FALSE)
 print("Results saved to 'correlation_results.xlsx'")
} else {
 print("Data vectors do not match in length for pre-war or war period. Please check your data.")
}
```

UKR: GDP vs INFLATION	Metric	Value
Pre-War	Covariance	-7.06451071
Pre-War	Pearson Correlation	-0.13182199
Pre-War	Spearman Correlation	-0.06666667
Pre-War	Kendall Correlation	-0.06666667
War	Covariance	-51.6253893
War	Pearson Correlation	-0.38742705
War	Spearman Correlation	-0.40606061
War	Kendall Correlation	-0.24444444

RUS: GDP vs INFLATION	Metric	Value
Pre-War	Covariance	-0.53785225
Pre-War	Pearson Correlation	-0.03998569
Pre-War	Spearman Correlation	0.32121212
Pre-War	Kendall Correlation	0.15555556
War	Covariance	-3.80134854
War	Pearson Correlation	-0.3472979
War	Spearman Correlation	-0.28571429
War	Kendall Correlation	-0.21428571

RUS: GDP per Capita vs UNEMPLOYMENT	Metric	Value
Pre-War	Covariance	-2845.71354
Pre-War	Pearson Correlation	-0.72258123
Pre-War	Spearman Correlation	-0.74545455
Pre-War	Kendall Correlation	-0.55555556
War	Covariance	-1369.17177
War	Pearson Correlation	-0.74565846
War	Spearman Correlation	-0.79393939
War	Kendall Correlation	-0.6

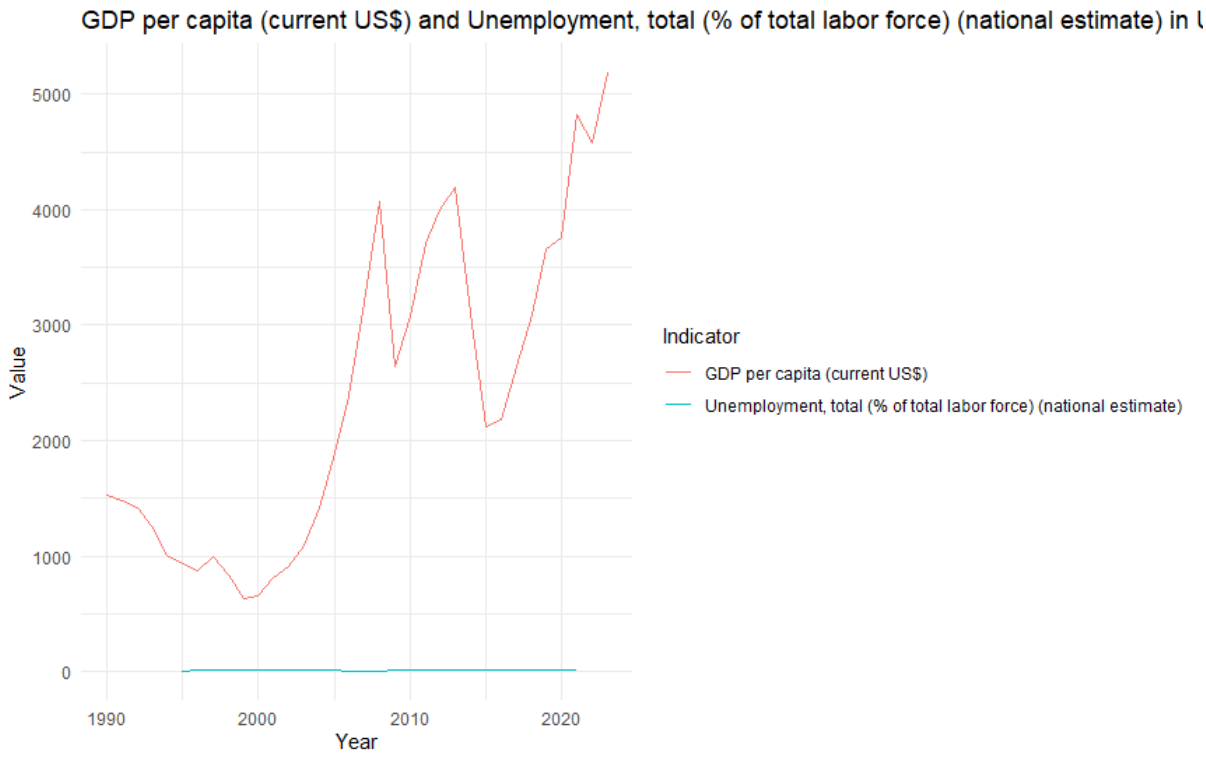
UKR: GDP per Capita vs UNEMPLOYMENT	Metric	Value
Pre-War	Covariance	-325.693793
Pre-War	Pearson Correlation	-0.3913221
Pre-War	Spearman Correlation	-0.40606061
Pre-War	Kendall Correlation	-0.33333333
War	Covariance	71.0790365
War	Pearson Correlation	0.15689026
War	Spearman Correlation	0.28571429
War	Kendall Correlation	0.21428571

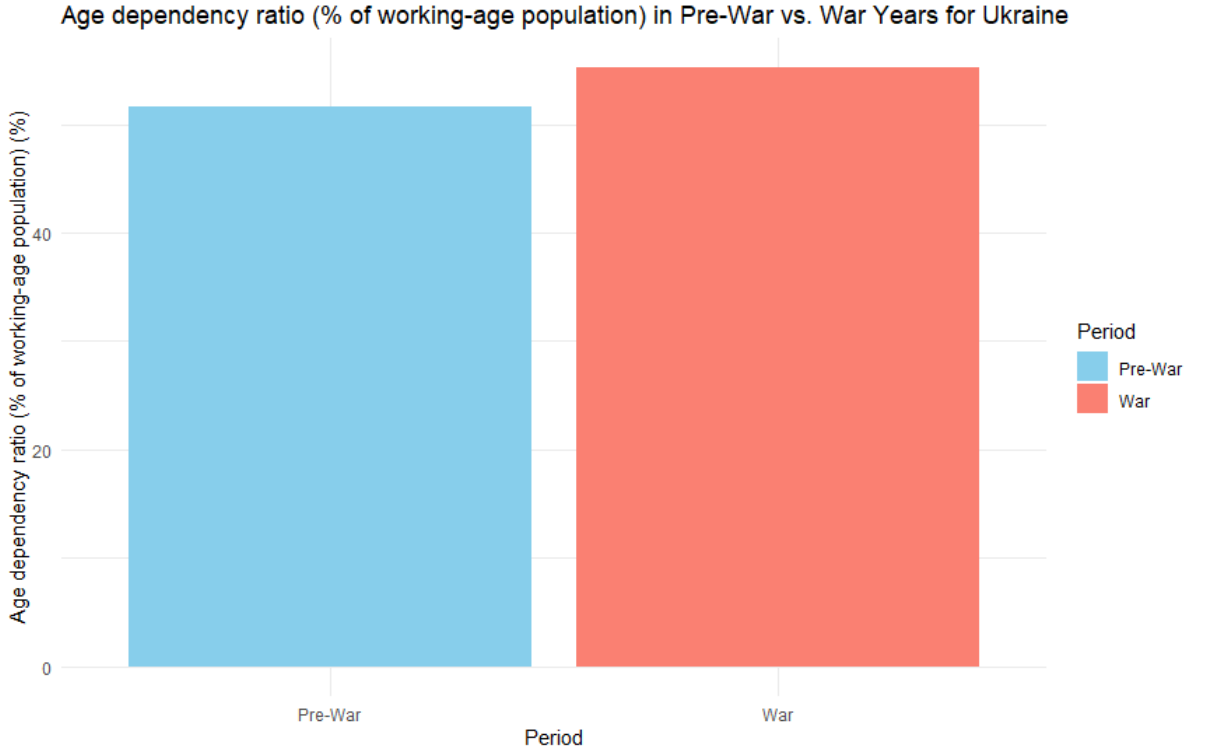
CODE D: Bar chart comparing age dependency ratio

```
# Load necessary libraries
library(ggplot2)
library(dplyr)

# Function to create the line graph for any two indicators across time
plot_indicators_line_graph <- function(dataB, country, start_year, end_year, indicator1, indicator2) {

  # Filter data for the specified country and time range
  filtered_data <- dataB %>%
    filter(Country == country, Year >= start_year, Year <= end_year)

  # Check if there's data for the specified filter
  if(nrow(filtered_data) == 0) {
    stop("No data available for the specified country and time range.")
  }

  # Create the line graph
```

```
  ggplot(filtered_data, aes(x = Year)) +
    geom_line(aes(y = .data[[indicator1]], color = indicator1)) +
    geom_line(aes(y = .data[[indicator2]], color = indicator2)) +
    labs(title = paste(indicator1, "and", indicator2, "in", country, "from", start_year, "to",
end_year),
         x = "Year",
         y = "Value",
         color = "Indicator") +
    theme_minimal()
}

# Function to create a bar chart for any single indicator (pre-war vs war years)
plot_single_indicator_bar_chart <- function(dataB, country, pre_war_years, war_years,
indicator) {

  # Filter data for the specified country and pre-war and war periods
  filtered_data <- dataB %>%
    filter(Country == country, Year %in% c(pre_war_years, war_years)) %>%
    mutate(Period = ifelse(Year %in% pre_war_years, "Pre-War", "War"))

  # Check if there's data for the specified filter
  if(nrow(filtered_data) == 0) {
    stop("No data available for the specified country and periods.")
  }

  # Create the bar chart
  ggplot(filtered_data, aes(x = Period, y = .data[[indicator]], fill = Period)) +
    geom_bar(stat = "identity", position = "dodge") +
    labs(title = paste(indicator, "in Pre-War vs. War Years for", country),
         x = "Period",
         y = paste(indicator, "(%)")) +
    theme_minimal() +
    scale_fill_manual(values = c("Pre-War" = "skyblue", "War" = "salmon"))
}

# Example usage: replace with your desired country, year range, and indicators
# Assuming 'dataB' is preloaded in your R environment with necessary columns
plot_indicators_line_graph(dataB, "Ukraine", 1990, 2023, "GDP per capita (current US$)",
"Unemployment, total (% of total labor force) (national estimate)")
```

#plot_single_indicator_bar_chart(dataB, "Ukraine", pre_war_years = 1990:2021, war_years = 2022:2023, "Age_dependency_ratio")

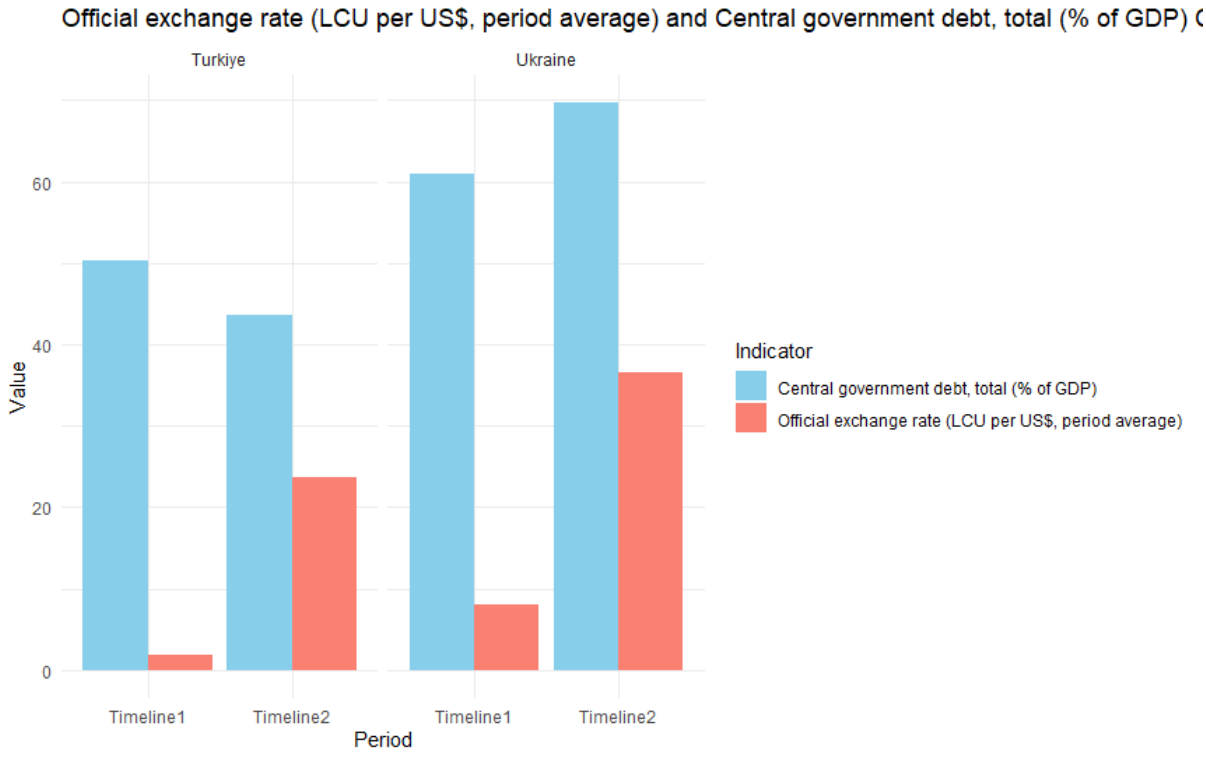




CODE E: Compare Exchange Rate Fluctuations And Government Debt Levels Between Pre-War And War Years.

```
# Load necessary libraries
library(ggplot2)
library(dplyr)
library(tidyr)  # For pivot_longer

# Function to create a side-by-side bar chart for two indicators and two countries over two periods
plot_comparison_bar_chart <- function(dataB, country1, country2, timeline1, timeline2, indicator1, indicator2) {

  # Convert dataB to a data.frame if it is not already
  dataB <- as.data.frame(dataB)

  # Filter data for the specified countries and periods
  filtered_data <- dataB %>%
    filter(Country %in% c(country1, country2), Year %in% c(timeline1, timeline2)) %>%
    mutate(Period = ifelse(Year %in% timeline1, "Timeline1", "Timeline2"))

  # Check if there's data for the specified filter
  if (nrow(filtered_data) == 0) {
    stop("No data available for the specified countries and periods.")
  }

  # Reshape data to long format for easier plotting
  data_long <- filtered_data %>%
    select(Country, Period, !!sym(indicator1), !!sym(indicator2)) %>%
    pivot_longer(cols = c(!!sym(indicator1), !!sym(indicator2)), names_to = "Indicator", values_to = "Value")

  # Create the side-by-side bar chart
  ggplot(data_long, aes(x = Period, y = Value, fill = Indicator)) +
    geom_bar(stat = "identity", position = "dodge") +
    facet_wrap(~ Country) +
    labs(title = paste(indicator1, "and", indicator2, "Comparison for", country1, "and", country2),
```

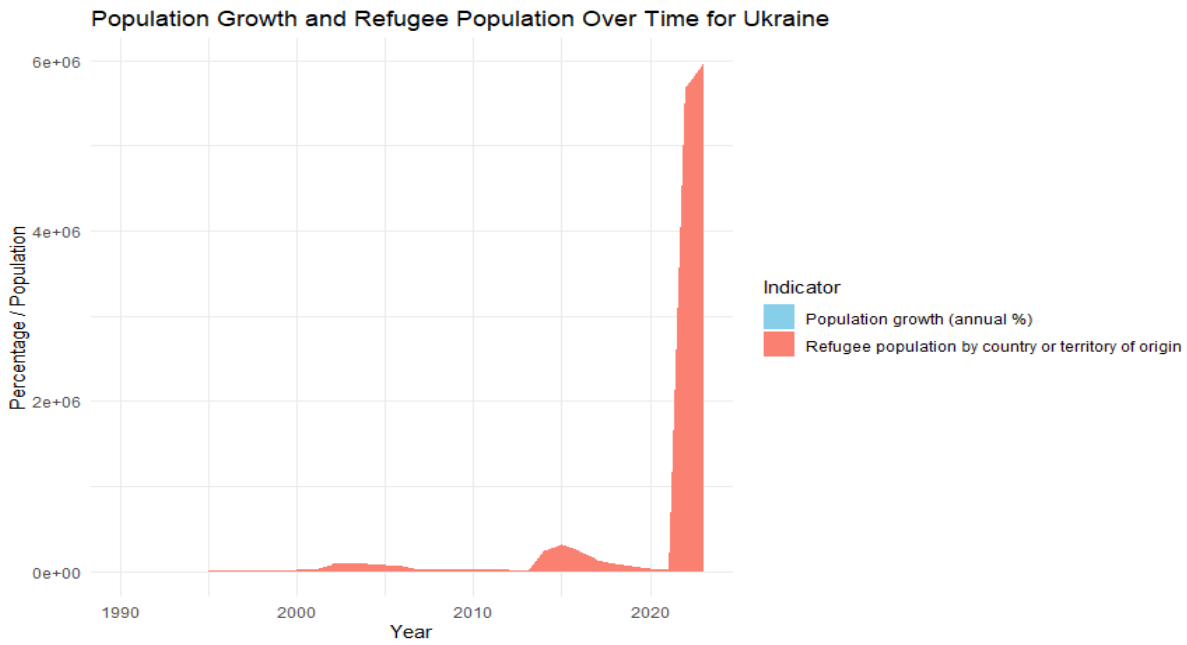
```
      x = "Period",
      y = "Value",
      fill = "Indicator") +
  theme_minimal() +
  scale_fill_manual(values = c("skyblue", "salmon"))
}

# Example usage: replace with your desired countries, timelines, and indicators
# Assuming 'dataB' is preloaded in your R environment with necessary columns
plot_comparison_bar_chart(dataB,
                          country1 = "Ukraine",
                          country2 = "Turkiye",
                          timeline1 = 1990:2013,
                          timeline2 = 2014:2023,
                          indicator1 = "Official exchange rate (LCU per US$, period average)",
                          indicator2 = "Central government debt, total (% of GDP)")
```



CODE F: Population growth and refugee population over time in Ukraine

```
# Load necessary libraries
library(ggplot2)
library(dplyr)
library(tidyr)

# Function to create a stacked area chart for population growth and refugee population
plot_stacked_area_chart <- function(dataB, country, start_year, end_year) {

 # Filter data for the given country and time range
 filtered_data <- dataB %>%
  filter(Country == country, Year >= start_year, Year <= end_year)

 # Check if there's data for the specified filter
 if (nrow(filtered_data) == 0) {
  stop("No data available for the specified country and time range.")
 }

 # Reshape the data to long format for ggplot
 data_long <- filtered_data %>%
  select(Year, `Population growth (annual %)`, `Refugee population by country or territory of origin`) %>%
  pivot_longer(cols = c(`Population growth (annual %)`, `Refugee population by country or territory of origin`),
               names_to = "Indicator",
               values_to = "Value")

 # Create the stacked area chart
 ggplot(data_long, aes(x = Year, y = Value, fill = Indicator)) +
  geom_area() +
  labs(title = paste("Population Growth and Refugee Population Over Time for", country),
       x = "Year",
       y = "Percentage / Population",
       fill = "Indicator") +
  theme_minimal() +
  scale_fill_manual(values = c("skyblue", "salmon"))
```

```
}
# Example usage: replace with your desired country and year range
# Assuming 'dataB' is preloaded in your R environment with necessary columns
plot_stacked_area_chart(dataB, country = "Ukraine", start_year = 1990, end_year = 2023)
```



CODE G: Urban vs Rural Population Growth

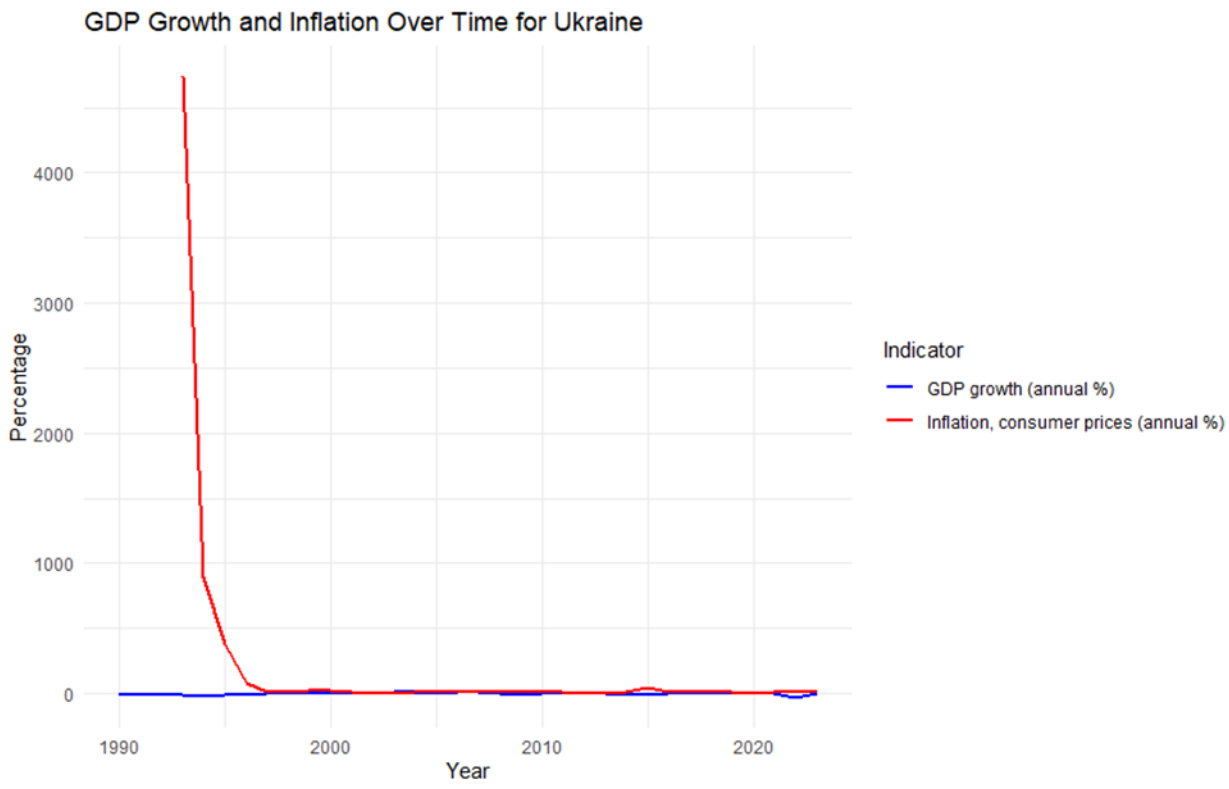
```
# Function to create a pie chart for rural vs. urban population growth
plot_pie_chart <- function(dataB, country, pre_war_years, war_years) {

 # Filter data for the specified country and periods
 filtered_data <- dataB %>%
  filter(Country == country, Year %in% c(pre_war_years, war_years)) %>%
  mutate(Period = ifelse(Year %in% pre_war_years, "Pre-War", "War"))

 # Check if there's data for the specified filter
 if (nrow(filtered_data) == 0) {
  stop("No data available for the specified country and periods.")
 }

 # Summarize the data for the pie chart (total urban vs rural growth)
 pie_data <- filtered_data %>%
  group_by(Period) %>%
```

```
  summarise(Total_urban_growth = sum(`Urban population growth (annual %)`, na.rm = TRUE),
            Total_rural_growth = sum(`Population growth (annual %)`, na.rm = TRUE) - Total_urban_growth) %>%
  pivot_longer(cols = c(Total_urban_growth, Total_rural_growth),
               names_to = "Indicator",
               values_to = "Value")

 # Create the pie chart
 ggplot(pie_data, aes(x = "", y = Value, fill = Indicator)) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar(theta = "y") +
  labs(title = paste("Urban vs Rural Population Growth for", country),
       fill = "Growth Type") +
  theme_void() +
  scale_fill_manual(values = c("skyblue", "salmon"))
}

# Example usage: replace with your desired country, year ranges
# Assuming 'dataB' is preloaded in your R environment with necessary columns
plot_pie_chart(dataB, country = "Ukraine", pre_war_years = 1990:2010, war_years = 2011:2023)
```

CODE H: Dual line graph - GDP growth and inflation rates

```
# Load necessary libraries
library(ggplot2)
library(dplyr)

# Function to create the dual line graph for GDP growth and inflation over time
plot_dual_line_graph <- function(dataB, country, start_year, end_year) {

  # Filter data for the given country and time range
  filtered_data <- dataB %>%
    filter(Country == country, Year >= start_year, Year <= end_year)

  # Check if there's data for the specified filter
  if (nrow(filtered_data) == 0) {
    stop("No data available for the specified country and time range.")
  }

  # Reshape the data to long format for ggplot
  data_long <- filtered_data %>%
    select(Year, `GDP growth (annual %)`, `Inflation, consumer prices (annual %)`) %>%
    pivot_longer(cols = c(`GDP growth (annual %)`, `Inflation, consumer prices (annual %)`),
                 names_to = "Indicator",
                 values_to = "Value")

  # Create the dual line graph
  ggplot(data_long, aes(x = Year, y = Value, color = Indicator)) +
    geom_line(size = 1) +
    labs(title = paste("GDP Growth and Inflation Over Time for", country),
         x = "Year",
         y = "Percentage",
         color = "Indicator") +
    theme_minimal() +
    scale_color_manual(values = c("blue", "red"))
}

# Example usage: replace with your desired country and year range
# Assuming 'dataB' is preloaded in your R environment with necessary columns
```

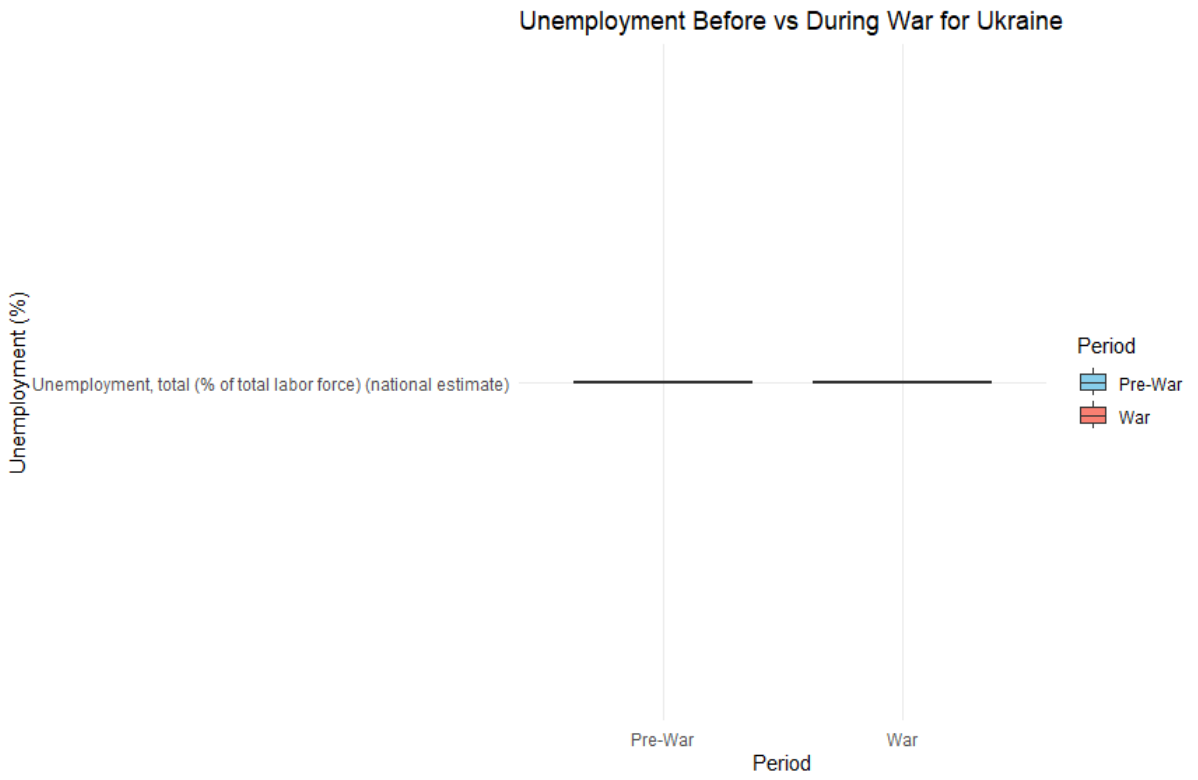
```
plot_dual_line_graph(dataB, country = "Ukraine", start_year = 1990, end_year = 2023)
```



CODE I: Unemployment Pre-War vs During War

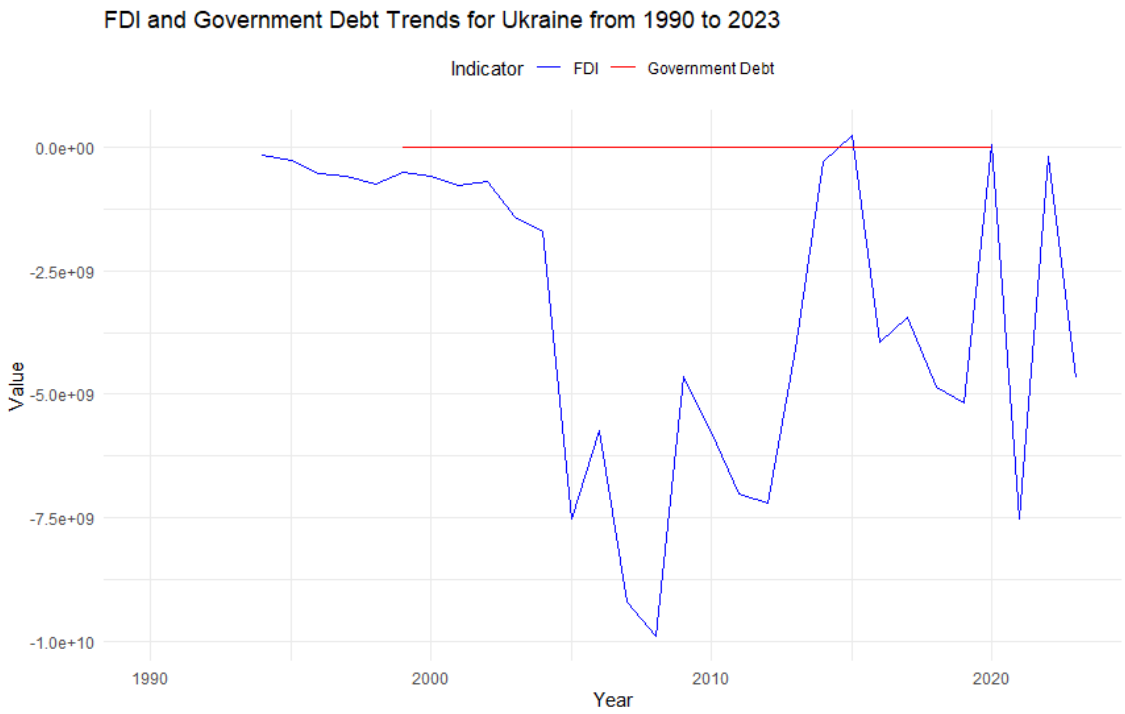
```
# Load necessary libraries
library(ggplot2)
library(dplyr)
# Function to create the box plot for unemployment before and during the war
plot_unemployment_box_plot <- function(dataB, country, pre_war_years, war_years) {

 # Check if dataB is a data frame
 if (!is.data.frame(dataB)) {
  stop("dataB is not a data frame!")
 }

 # Filter data for the specified country and time range
 filtered_data <- dataB %>%
  filter(Country == country, Year %in% c(pre_war_years, war_years)) %>%
  mutate(Period = ifelse(Year %in% pre_war_years, "Pre-War", "War"))

 # Check if there's data for the specified filter
```

```
 if (nrow(filtered_data) == 0) {
  stop("No data available for the specified country and periods.")
 }

 # Create the box plot for unemployment
 ggplot(filtered_data, aes(x = Period, y = 'Unemployment, total (% of total labor force) (national estimate)', fill = Period)) +
  geom_boxplot() +
  labs(title = paste("Unemployment Before vs During War for", country),
       x = "Period",
       y = "Unemployment (%)") +
  theme_minimal() +
  scale_fill_manual(values = c("Pre-War" = "skyblue", "War" = "salmon"))
}

# Example usage: replace with your desired country and year range
# Example usage for Ukraine
plot_unemployment_box_plot(dataB, country = "Ukraine", pre_war_years = 1990:2021, war_years = 2022:2023)
```



CODE J: Trends Of Foreign Direct Investment and Government Debt

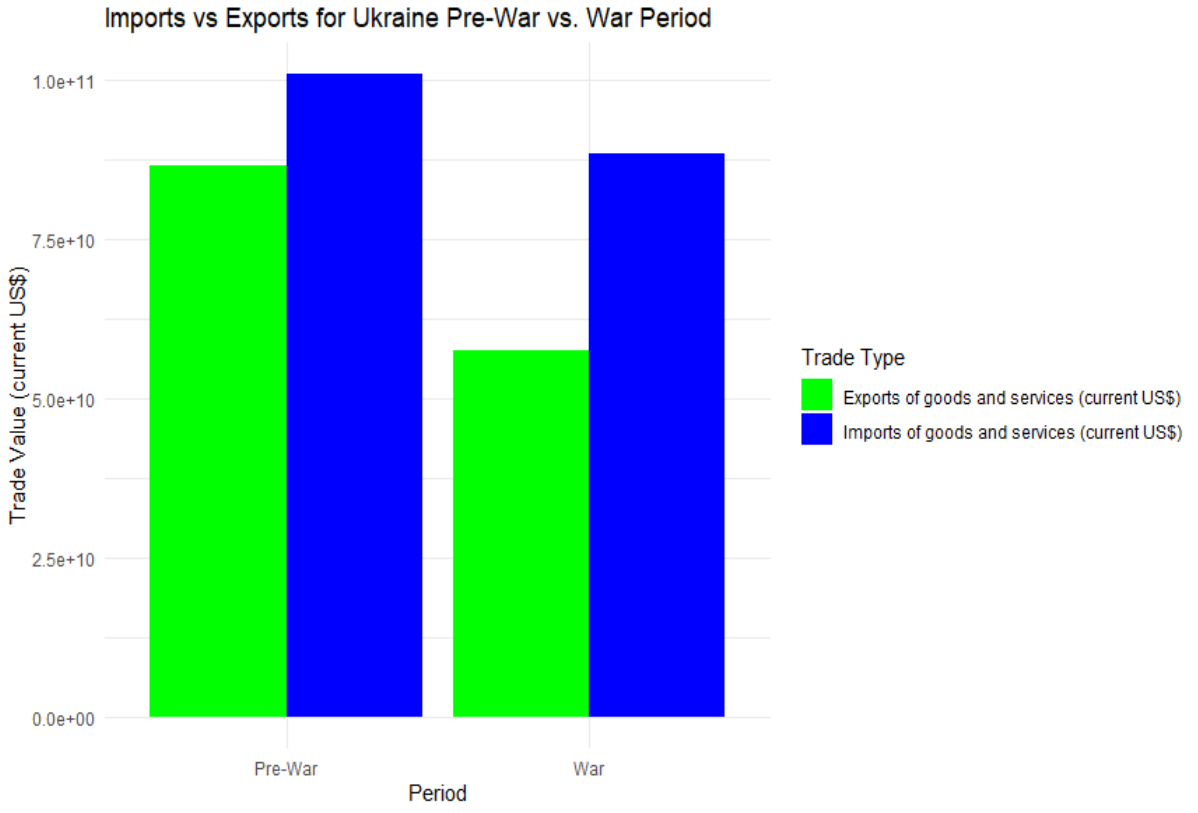
```
# Load necessary libraries
library(ggplot2)
library(dplyr)

# Function to create the line graph for FDI and government debt comparison
plot_fiscal_strain_line_graph <- function(dataB, country, start_year, end_year) {

  # Filter data for the specified country and time range
  filtered_data <- dataB %>%
    filter(Country == country, Year >= start_year, Year <= end_year)

  # Check if there's data for the specified filter
  if(nrow(filtered_data) == 0) {
    stop("No data available for the specified country and time range.")
  }

  # Create the line graph comparing FDI and government debt
  ggplot(filtered_data, aes(x = Year)) +
    geom_line(aes(y = `Foreign direct investment, net (BoP, current US$)`, color = "FDI")) +
    geom_line(aes(y = `Central government debt, total (% of GDP)`, color = "Government
Debt")) +
    labs(title = paste("FDI and Government Debt Trends for", country, "from", start_year, "to",
end_year),
         x = "Year",
         y = "Value",
         color = "Indicator") +
    scale_color_manual(values = c("FDI" = "blue", "Government Debt" = "red")) +
    theme_minimal() +
    theme(legend.position = "top")
}

# Example usage: replace with your desired country and year range
# Example usage for Ukraine, from 1990 to 2023
plot_fiscal_strain_line_graph(dataB, country = "Ukraine", start_year = 1990, end_year =
2023)
```



CODE K: Imports vs. Exports

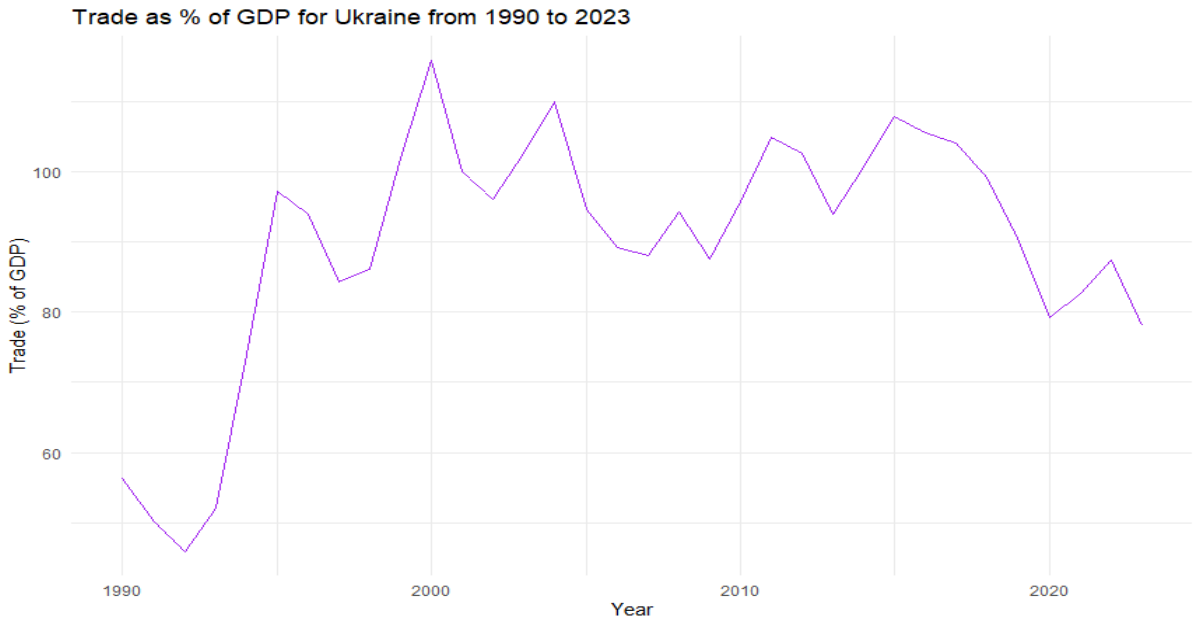
```
# Load necessary libraries
library(ggplot2)
library(dplyr)

# Function to create the clustered bar chart for Imports vs. Exports pre-war and during war
plot_trade_comparison_bar_chart <- function(dataB, country, pre_war_years, war_years) {

  # Filter data for the specified country and pre-war and war periods
  filtered_data <- dataB %>%
    filter(Country == country, Year %in% c(pre_war_years, war_years)) %>%
    mutate(Period = ifelse(Year %in% pre_war_years, "Pre-War", "War"))

  # Check if there's data for the specified filter
  if(nrow(filtered_data) == 0) {
    stop("No data available for the specified country and periods.")
  }

  # Reshape data to long format for easier plotting (Imports vs Exports)
  data_long <- filtered_data %>%
    select(Country, Period, `Imports of goods and services (current US$)`, `Exports of goods and services (current US$)`) %>%
```

```
  pivot_longer(cols = c(`Imports of goods and services (current US$)`, `Exports of goods and
services (current US$)`),
               names_to = "Trade_Type", values_to = "Value")

 # Create the clustered bar chart
 ggplot(data_long, aes(x = Period, y = Value, fill = Trade_Type)) +
  geom_bar(stat = "identity", position = "dodge") +
  labs(title = paste("Imports vs Exports for", country, "Pre-War vs. War Period"),
       x = "Period",
       y = "Trade Value (current US$)",
       fill = "Trade Type") +
  theme_minimal() +
  scale_fill_manual(values = c("Imports of goods and services (current US$)" = "blue",
                               "Exports of goods and services (current US$)" = "green"))
}

# Example usage: replace with your desired country, pre-war years, and war years
# Example usage for Ukraine
plot_trade_comparison_bar_chart(dataB, country = "Ukraine", pre_war_years = 1990:2021,
war_years = 2022:2023)
```



CODE L: Line Graph for Trade

```
# Function to create the line graph for Trade as a percentage of GDP over time
plot_trade_percentage_of_gdp <- function(dataB, country, start_year, end_year) {

  # Filter data for the specified country and time range
  filtered_data <- dataB %>%
    filter(Country == country, Year >= start_year, Year <= end_year)

  # Check if there's data for the specified filter
  if(nrow(filtered_data) == 0) {
    stop("No data available for the specified country and time range.")
  }
  # Create the line graph for Trade (% of GDP)
  ggplot(filtered_data, aes(x = Year, y = `Trade (% of GDP)`)) +
    geom_line(color = "purple") +
    labs(title = paste("Trade as % of GDP for", country, "from", start_year, "to", end_year),
         x = "Year",
         y = "Trade (% of GDP)") +
    theme_minimal()
}
# Example usage: replace with your desired country and year range
# Example usage for Ukraine from 1990 to 2023
plot_trade_percentage_of_gdp(dataB, country = "Ukraine", start_year = 1990, end_year =
2023)
```

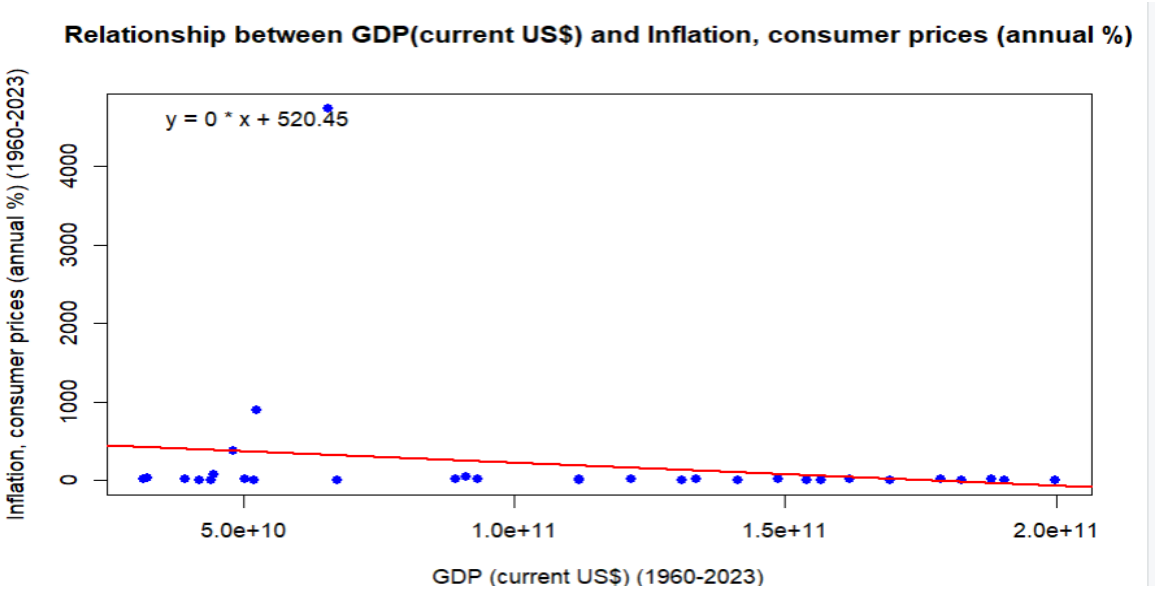


CODE M: Regression for GDP and Inflation

```
data=imputedA
countr <- split(data,data$CountryCode)
rus=countr$"UKR"
# Assuming 'rus' contains the data for Ukraine
# Subset the data for the years 2004 to 2013
x<- rus[, c("CountryCode", "Indicator", as.character(1960:2023))]
x=subset(x,Indicator=="GDP (current US$)")
y<-rus[, c("CountryCode", "Indicator", as.character(1960:2023))]
y=subset(y,Indicator=="Inflation, consumer prices (annual %)")
# Assuming 'x' and 'y' contain only the rows for the specified IndicatorCode and years
# Load necessary library for interpolation if needed
# install.packages("zoo")
library(zoo)
# Extract the numeric values for each year range
x_values <- as.numeric(unlist(x[, as.character(1960:2023)]))
y_values <- as.numeric(unlist(y[, as.character(1960:2023)]))
# Check lengths and adjust if necessary
if (length(x_values) != length(y_values)) {
  min_length <- min(length(x_values), length(y_values))
  x_values <- x_values[1:min_length]
  y_values <- y_values[1:min_length]
}
# Run the regression if lengths are equal
if (length(x_values) == length(y_values)) {
  reg <- lm(y_values ~ x_values)
  summary(reg)
  # Plot with regression line
  plot(x_values, y_values,
       main = "Relationship between Pre-War and War Period Indicators",
       xlab = "GDP (current US$) (1960-2023)",
       ylab = "Inflation, consumer prices (annual %) (1960-2023)",
       pch = 16, col = "blue")
abline(reg, col = "red", lwd = 2)
# Optionally, add text to show the equation on the plot
eq <- paste("y =", round(coef(reg)[2], 2), "* x +", round(coef(reg)[1]    ,2))
legend("topleft", legend = eq, col = "red", bty = "n")
} else {
  cat("Error: x_values and y_values still differ in length.")
}
lm(x_values~y_values,data=rus)
```

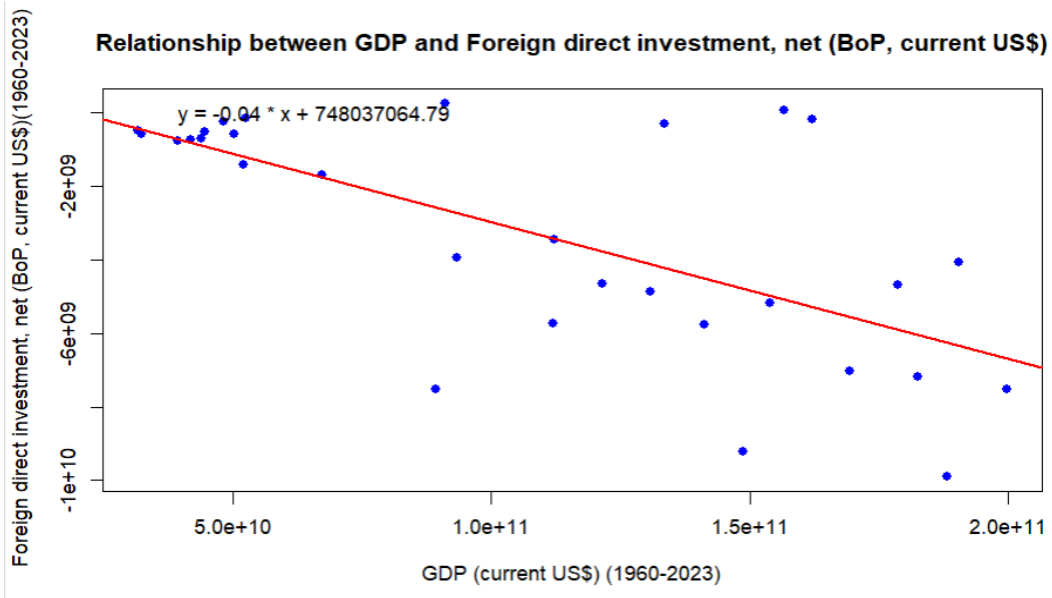
Simple Linear Regression: Relationship between GDP and inflation:

```
Call:
lm(formula = x_values ~ y_values, data = rus)

Coefficients:
(Intercept)     y_values
  1.098e+11   -1.241e+07
```



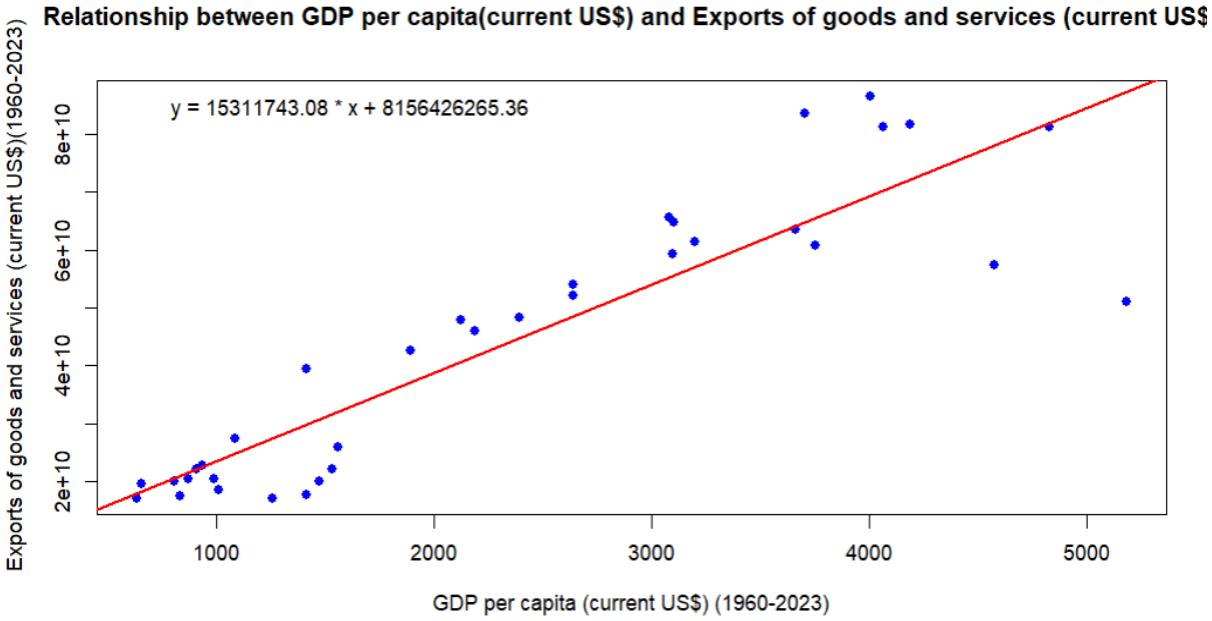
Linear Regression: Foreign direct investment as a predictor of GDP:

```
Call:
lm(formula = x_values ~ y_values, data = rus)

Coefficients:
(Intercept)     y_values
  6.890e+10   -1.206e+01
```



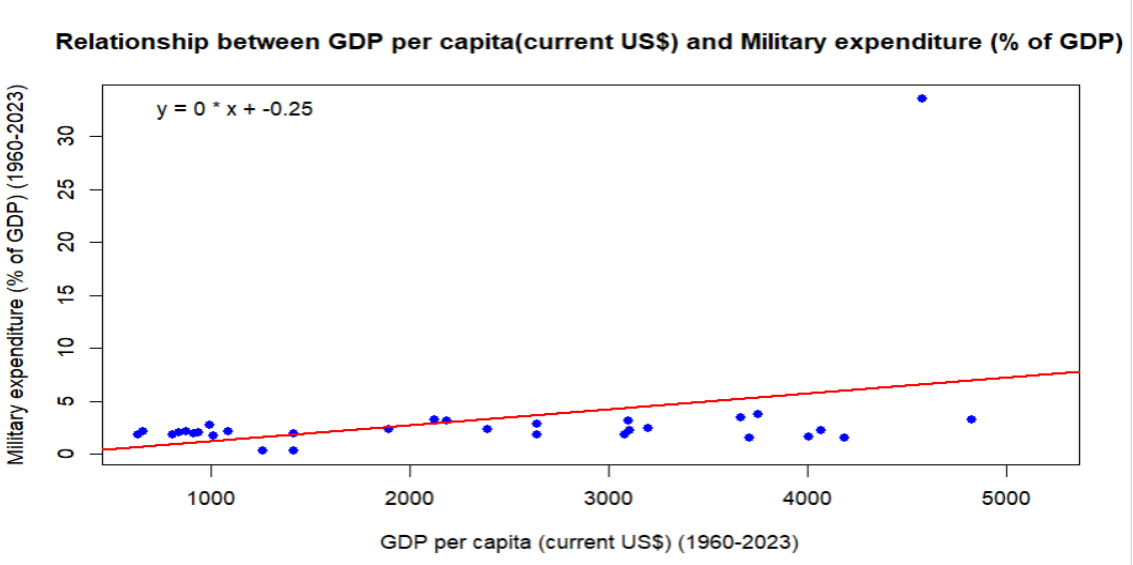
Linear Regression: Exports on GDP per capita.

```
Call:
lm(formula = x_values ~ y_values, data = rus)

Coefficients:
(Intercept)     y_values
  3.350e+01    5.241e-08
```



Linear Regression: Military expenditure's effect on GDP.

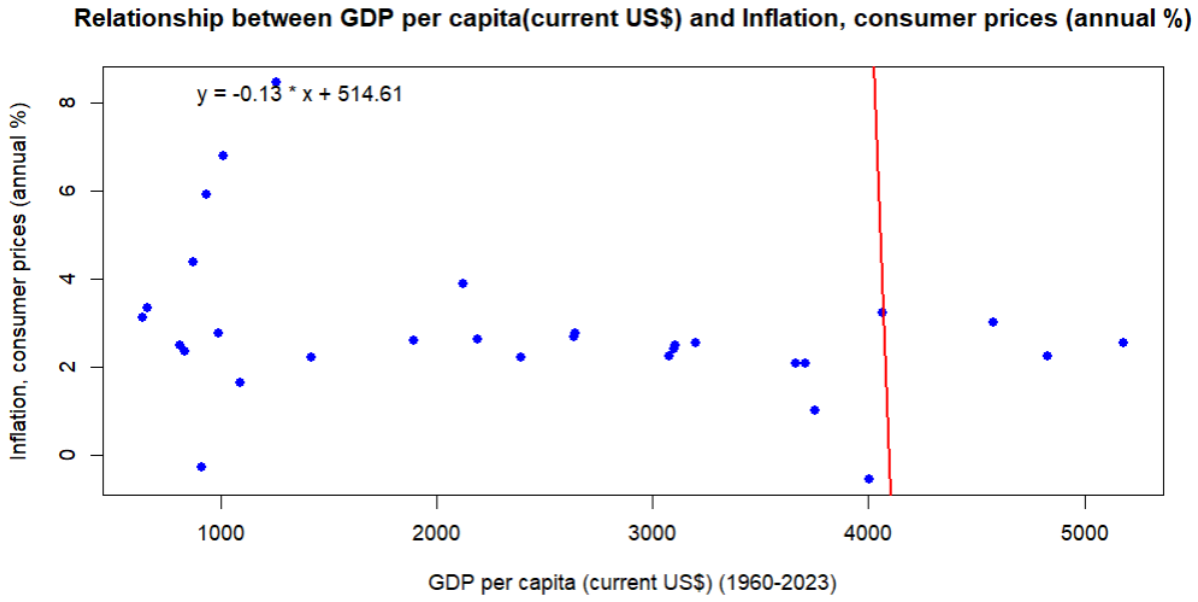
```
Call:
lm(formula = x_values ~ y_values, data = rus)

Coefficients:
(Intercept)     y_values
    2052.08        83.15
```



Nonlinear Regressions

Logarithmic Transformation: Log transformation of inflation predicting GDP.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)     3152.0      470.1   6.705 2.81e-07 ***
log(y_values)   -269.9      141.1  -1.912   0.0661 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1343 on 28 degrees of freedom
  (34 observations deleted due to missingness)
Multiple R-squared:  0.1155,    Adjusted R-squared:  0.08394
F-statistic: 3.657 on 1 and 28 DF,  p-value: 0.06611
```



CODE N1: Hypothesis Testing

```
Install and load necessary packages
install.packages("readxl")
library(readxl)

# Load the data from the specified path
data <- read_excel("imputed_data.xlsx")

# Inspect the data
head(data)
```

```
str(data)

# Define the war years
war_years <- c("2003", "2004", "2005", "2006", "2007", "2008", "2009", "2010", "2011")

# Filter data for specific indicators and war timeframes
gdp_growth <- data[data$Indicator == "GDP growth (annual %)", war_years]
inflation <- data[data$Indicator == "Inflation, consumer prices (annual %)", war_years]

# Perform a z-test (assuming large sample size)
z_test_result <- t.test(as.numeric(unlist(gdp_growth)), as.numeric(unlist(inflation)))
print(z_test_result)

# Perform an F-test to compare variances
f_test_result <- var.test(as.numeric(unlist(gdp_growth)), as.numeric(unlist(inflation)))
print(f_test_result)

# Perform a t-test to compare means
t_test_result <- t.test(as.numeric(unlist(gdp_growth)), as.numeric(unlist(inflation)))
print(t_test_result)

# Perform a paired t-test (if the data is paired)
paired_t_test_result  <-  t.test(as.numeric(unlist(gdp_growth)),  as.numeric(unlist(inflation)),
paired = TRUE)
print(paired_t_test_result)

# Perform ANOVA to compare means of multiple groups
anova_data <- data.frame(
  gdp_growth = as.numeric(unlist(gdp_growth)),
  inflation = as.numeric(unlist(inflation))
)
anova_result <- aov(gdp_growth ~ inflation, data = anova_data)
summary(anova_result)

# Perform a chi-square test to compare frequencies
chi_square_data <- table(data$Country, data$Indicator)
chi_square_result <- chisq.test(chi_square_data)
print(chi_square_result)
```

CODE N2: Basic Ranking

```
# Load necessary libraries
library(dplyr)
library(tidyr)

# Load the data
data <- read.csv("final.csv")

# Specify the country and years for calculating the change
country_to_rank <- "Afghanistan"  # Replace with desired country
start_year <- 2010  # Replace with the starting year
end_year <- 2021    # Replace with the ending year

# Filter data for the chosen country and years
data_filtered <- data %>%
  filter(Country == country_to_rank, Year %in% c(start_year, end_year)) %>%
  select(-Country, -CountryCode) %>%  # Exclude CountryCode column
  pivot_longer(cols = -Year, names_to = "Indicator", values_to = "Value")

# Separate the values for start and end years and calculate the change
ranked_changes <- data_filtered %>%
  pivot_wider(names_from = Year, values_from = Value, names_prefix = "Year_") %>%
  mutate(Change = abs(Year_2021 - Year_2010)) %>%
  arrange(desc(Change)) %>%
  #select(Indicator, Change) %>%
  select(Indicator) %>%
  mutate(Rank = row_number())
# Display the ranked changes
print(ranked_changes)
```

Indicator	2010	2021	Change	Rank
GDP (current US$)	15856668556	1.4266E+10	1.59E+09	1
GNI (current US$)	15885775064	1.4353E+10	1.53E+09	2
Merchandise exports (current US$)	388000000	850000000	4.62E+08	3
Merchandise imports (current US$)	5154000000	5308000000	1.54E+08	4

Population, total	28189672	40099462	11909790	5
Refugee population by country or territory of origin	3054699	2712869	341830	6
Refugee population by country or territory of asylum	6434	66949	60515	7
GDP per capita (current US$)	562.4992216	355.777826	206.7214	8
GDP growth (annual %)	14.36244147	-20.7388394	35.10128	9
Age dependency ratio (% of working-age population)	105.4334164	84.599257	20.83416	10
Net barter terms of trade index (2015 = 100)	93.98909869	106.029777	12.04068	11
External debt stocks, short-term (DOD, current US$)	15.33349745	24.7744403	9.440943	12
Manufacturing, value added (% of GDP)	12.52257684	8.49315682	4.02942	13
External health expenditure (% of current health expenditure)	15.52872467	19.3480263	3.819302	14
Urban population (% of total population)	23.737	26.314	2.577	15
Services, value added (% of GDP)	48.87937691	47.1604224	1.718955	16
Urban population growth (annual %)	3.779279064	3.95185729	0.172578	17
Rural population growth (annual %)	2.621229215	2.46127474	0.159954	18
Military expenditure (% of GDP)	1.945835694	1.82793386	0.117902	19
Population growth (annual %)	2.894904104	2.85135765	0.043546	20
Adjusted net savings, excluding particulate emission damage (% of GNI)				21
Agricultural raw materials exports (% of merchandise exports)	10.76704582			22
Central government debt, total (% of GDP)				23
Current account balance (% of GDP)	-3.643313882			24
Employment to population ratio, 15+, total (%) (national estimate)		46.906		25
Exports of goods and services (current US$)		2046123147		26
Foreign direct investment, net (BoP, current US$)	-192022479.5			27
General government final consumption expenditure (% of GDP)		21.2623844		28

Government expenditure on education, total (% of GDP)	3.479449987			29
Gross fixed capital formation (% of GDP)		12.9867037		30
Gross savings (% of GDP)				31
High-technology exports (% of manufactured exports)				32
Imports of goods and services (current US$)		5288529076		33
Inflation, consumer prices (annual %)	2.178537524			34
Labor force participation rate for ages 15-24, total (%) (national estimate)		39.213		35
Labor force participation rate, total (% of total population ages 15+) (national estimate)		49.73		36
Net foreign assets (current LCU)	2.48099E+11			37
Official exchange rate (LCU per US$, period average)	46.452461			38
Revenue, excluding grants (% of GDP)	11.09194916			39
Tariff rate, applied, weighted mean, all products (%)				40
Tax revenue (% of GDP)	9.169751919			41
Total reserves minus gold (current US$)	4174367358			42
Trade (% of GDP)		51.4117164		43
Unemployment, female (% of female labor force) (national estimate)		5.519		44
Unemployment, male (% of male labor force) (national estimate)		5.73		45
Unemployment, total (% of total labor force) (national estimate)		5.679		46
Unemployment, youth female (% of female labor force ages 15-24) (national estimate)		9.433		47
Unemployment, youth male (% of male labor force ages 15-24) (national estimate)		8.547		48
Unemployment, youth total (% of total labor force ages 15-24) (national estimate)		8.785		49