

ECON F244

ECONOMICS OF GROWTH & DEVELOPMENT

Assignment Report

Group 9

Group Members:

Aavula Kaartavaraya	2022B3A70290H
Akhil Mohammad	2022B3A70360H
Nidhi Kolachana	2022B3A70387H
Parikshit Dashetwar	2022B3A70492H
Bishwa Bhusan Saha	2022B3A70494H
Siddhant Shukla	2022B3AA1655H

Introduction

We have selected the following 12 countries for our regression. We have divided them into 3 groups.

1. Developed/Advanced Economies:

- USA
- Germany
- Japan
- UK
- Australia
- Israel

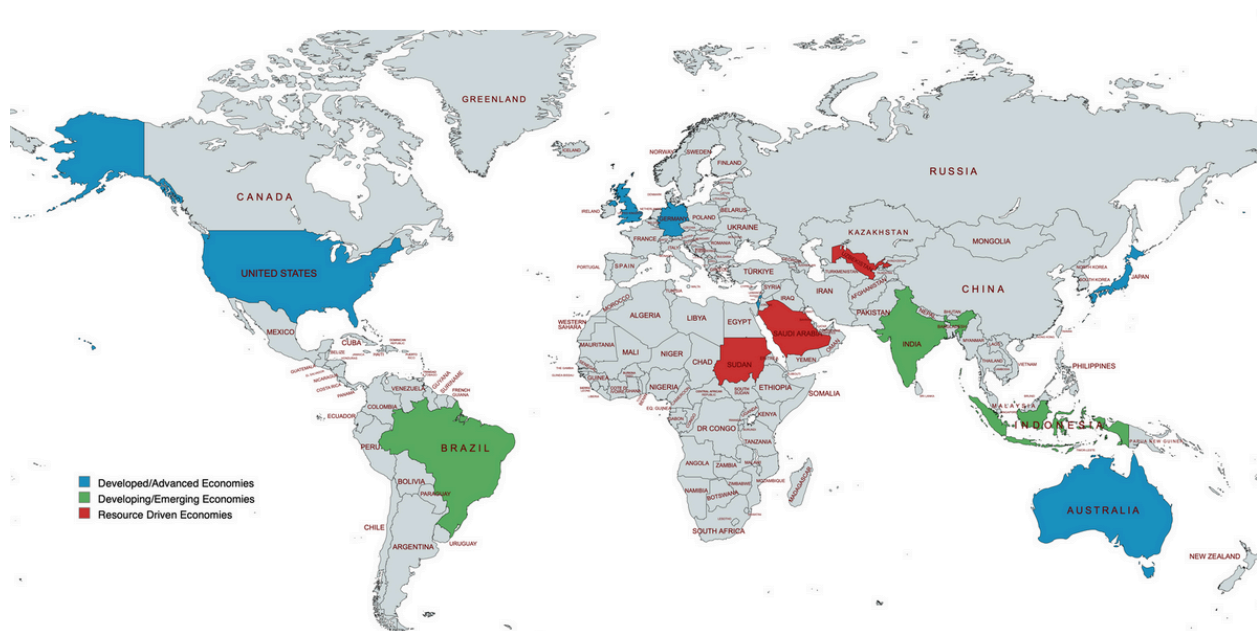
2. Developing/Emerging Economies:

- Brazil
- India (Lower-middle income economy, Newly industrialized country)
- Indonesia (Newly industrialized country)

3. Resource-driven and Developing Economies:

- Saudi Arabia
- Uzbekistan
- Sudan

By grouping the countries into the three groups, we ensure we have a wide range of economic conditions, policy approaches, and developmental challenges for our regression model.



Key points for the selection of Developed/Advanced Economies (USA, Germany, Japan, UK, Australia, Israel):

1. Economic Leadership:
 - These countries are global economic leaders, contributing significantly to international trade, finance, and innovation.
 - Their economic decisions and policies have a substantial impact on the global economic landscape, making them crucial for understanding broader economic trends.
2. Diverse Economic Models:
 - Despite being developed economies, each country follows a distinct economic model and governance structure.
 - Analyzing this group allows us to identify the variations in policy approaches, regulatory frameworks, and institutional structures.
3. Innovation and Stability:
 - These nations are at the forefront of technological innovation and have stable political environments with well-established institutions.
 - Studying their approaches to innovation and maintaining stability provides valuable insights into the factors that contribute to sustained economic growth.

In essence, this selection enables a focused examination of economic leadership, diverse models, and the interplay of innovation and stability within highly developed nations.

Main points for the selection of Developing/Emerging Economies (Brazil, India, Indonesia):

1. Dynamic Growth Trajectories:
 - These countries represent dynamic and rapidly growing economies in different stages of development.
 - Brazil, India, and Indonesia showcase diverse growth trajectories, including lower-middle-income and newly industrialized statuses, providing insights into the challenges and opportunities associated with emerging market economies.
2. Demographic Significance:
 - With large and diverse populations, Brazil, India, and Indonesia play a crucial role in shaping global demographics.
 - Analyzing these economies allows us to understand the impact of population growth, urbanization, and demographic transitions on economic development and sustainability.
3. Transitioning Economies:
 - Brazil, India, and Indonesia are undergoing significant economic transitions, marked by industrialization, urbanization, and shifts in economic structures.

- Studying these transitions helps uncover the factors influencing the successful progression from developing to developed status, offering valuable lessons for other emerging economies.

In summary, the selection of these Developing/Emerging Economies enables a focused examination of their dynamic growth trajectories, demographic significance, and the ongoing economic transitions. Understanding the unique challenges and opportunities in these nations contributes to a broader understanding of the factors driving development in emerging markets.

Main points for the selection of Resource-driven and Developing Economies (Saudi Arabia, Uzbekistan, Sudan):

1. Resource Dependency:
 - These countries are characterized by a significant reliance on natural resources, such as oil in the case of Saudi Arabia.
 - Analyzing resource-driven economies helps understand the challenges and opportunities associated with managing and diversifying economies heavily dependent on natural resources.
2. Economic Diversification Efforts:
 - Saudi Arabia, Uzbekistan, and Sudan are actively engaged in efforts to diversify their economies beyond resource dependence.
 - Studying their strategies and progress in economic diversification provides insights into the complexities of transitioning from resource-driven to more diverse and sustainable economic models.
3. Geopolitical and Regional Dynamics:
 - The selected countries operate within specific geopolitical and regional contexts, influencing their economic policies and development trajectories.
 - Understanding how geopolitical factors and regional dynamics shape economic strategies in these resource-driven economies is crucial for a comprehensive analysis.

In summary, the selection of Resource-driven and Developing Economies allows for an in-depth exploration of their reliance on natural resources, ongoing efforts in economic diversification, and the impact of geopolitical and regional dynamics on economic development. Examining these aspects contributes to a nuanced understanding of the challenges and opportunities faced by resource-driven economies in their pursuit of sustainable growth.

Sample

12 diverse countries have been selected to run the regression. All data has been retrieved from the [World Bank Open Data](#)'s API within the Google Colab Notebook (Python file).

As requested in the problem description, PCGDP (Per Capita GDP) and its logarithmic value has been calculated and used as a feature. To account for Human Capital we used Net Enrollment in Tertiary Sector. Savings has been directly extracted from the API itself. No calculation was done in the script.

Further, more features were incorporated into the regression. Life Expectancy, Dependency Ratio, Population and FDI were used.

To calculate the GDP growth rate, we used the formula as given, $growth\ rate\ \% = \frac{GDP_{t+1} - GDP_t}{GDP_t}$.

Further, the countries were categorized into four buckets as the follows and were given categorical values of 1, 2, 3, and 4, respectively:

1. Highly Developed Economies:

- USA
- Germany
- Japan

2. Developed Economies:

- UK
- Australia
- Israel

3. Developing Economies:

- Brazil
- India
- Indonesia

4. Underdeveloped Economies:

- Saudi Arabia
- Uzbekistan
- Sudan

Reasoning for the variables:

PCGDP:

Per capita gross domestic product (PCGDP) is the ratio of the gross domestic product to the total population of the country and can thus accurately compare the economic progress of countries.

Net Enrollment in Tertiary Sector:

Tertiary sector is crucial for economic growth of a country as it contributes to both the primary and secondary sectors. Work in tertiary sector requires a decent level of education and skill training of human capital. Hence, net enrollment in tertiary sector is taken as a variable to account for human capital and importance of the sector.

Dependency Ratio:

Dependency ratio is the ratio of the number of dependents to the working population of a region and can thus give an accurate picture of the magnitude of the economically unproductive group that do not contribute to GDP.

Population:

Population of a country gives us a clear idea about the quantity of resources, products and services required by the country and the progress required to reach that level.

FDI:

Foreign Direct Investment tells us about the involvement of foreign investors in our country which is thus a measure of our economic progress that makes it attractive for foreigners to invest in.

Life Expectancy:

Life expectancy is the average number of years a person is expected to live. The expectation is that people will contribute more to a nation's economic progress the longer they live.

Methodology

Multiple data preprocessing methods have been implemented to find the significance of economic factors more accurately.

1. To increase the number of data points, a shift function was used to find the increase in GDP for every year from 1980 to 2020, instead of only time periods of five. Higher number of time periods increase the data size leading to more accurate models.
2. The logarithmic function is usually applied to features with a very high range. The logarithmic function was applied to the FDI and Population features, here.
3. To account for the country of the data point, (which would tell us how important it is for a country to be developed or not for it to contribute to GDP increase) we initially used dummy variables for all 12 countries but later ran into an error of overfitting. The R-squared parameter threw a value of 1.0 and all the weights of the economic variables fell to the order of 10^{-16} except the 12 country dummy variables.

So in order to solve this, the countries were divided into four categories: USA, UK and Germany as highly developed countries and were assigned an attribute of one, and Australia, Japan, Israel were taken as developed countries, India, Indonesia, Brazil as developing countries and Saudi Arabia, Sudan and Uzbekistan as Underdeveloped countries. (Explained in the Sample part of the report as well).

Regression and Interpretation

The regression yielded the following results:

Feature	Coefficient
Savings	0.388641
Net Enrollment Rate in Tertiary Education	-0.278507
Life Expectancy	-1.179070
Dependency Ratio	-0.238805
Countries	-0.027400
PCGDP	0.854376
FDI_log	0.193514
Population_log	-0.151001

And an intercept value of 0.0282611.

General intuition of interpreting feature coefficients/weights:

A weight of 0.3 means that an increase in 1 in the feature contributes to 0.3 in the final output. So a higher weight means a higher correlation between the output and the feature and a lower weight means no correlation. A negative weight can be interpreted with the same rules that it negatively affects the output.

Features:

Savings (0.388):

Having a Savings coefficient of 0.388 can be interpreted as a high correlation. Savings can therefore be seen as an important factor for growth of GDP of a country.

PCGDP (0.889): This is the strongest positive correlation according to the weights. An increase of 1 unit in PCGDP is associated with an increase of 0.889 in GDP. This makes sense intuitively, as countries with a higher GDP per capita tend to have stronger economies overall.

FDI_log (0.183): The coefficient is positive, indicating a positive correlation between foreign direct investment (FDI) and GDP. An increase of 1 unit in FDI_log (the log of FDI) is associated with an increase of 0.183 in GDP. This aligns with the intuition that countries attracting more foreign investment tend to have more capital to invest in businesses and infrastructure, which can lead to economic growth.

Net Enrollment Rate in Tertiary Education: -0.330460 (Negative)

The negative weight here is counterintuitive. However, it could be that the model is capturing the short-term costs of tertiary education (fees, foregone income while studying) without fully accounting for long-term productivity gains from a highly educated workforce. There may also be issues with the quality and job-relevance of tertiary education across this sample of countries. It could also be due to the increase in demand for skills rather than degrees. It could be possible that people currently unemployed or not pursuing tertiary education have more time to build skills.

Life Expectancy (-1.170): This is the strongest negative correlation according to the weights. An increase of 1 unit in life expectancy is associated with a decrease of 1.170 in GDP. This seems counterintuitive on the surface, but there could be a few explanations. One possibility is that countries with higher life expectancy also have higher elderly populations, which can strain social safety nets. Another possibility is that developing countries tend to have lower life expectancies, and these same countries may also have lower GDPs.

Dependency Ratio (-0.218): This coefficient is negative, indicating a negative correlation between dependency ratio and GDP. An increase of 1 unit in dependency ratio is associated with a decrease of 0.218 in GDP. This makes sense intuitively, as a higher dependency ratio means there are more people who are not working to support those who are. This can put a strain on an economy.

Population_log: -0.182010 (Negative)

The negative coefficient for the log of population size could also reflect the economic challenges associated with rapid population growth, especially in developing countries. Rapidly growing populations can strain resources, infrastructure, and public services, potentially hindering economic productivity and GDP growth per capita if not matched by commensurate investment and policy responses.

Many economic models suggest that extremely high population growth rates can impede development by overwhelming capacities for providing education, healthcare, housing, and employment opportunities. While a larger population can provide labor force growth, unchecked rapid growth outpacing capital accumulation can reduce capital/worker ratios and depress productivity.

Savings: 0.317991 (Positive)

A higher savings rate can facilitate more investment in productive capital, infrastructure, and research & development, which can drive economic growth. Countries with higher savings rates are able to fund more domestic investment and rely less on foreign capital inflows.

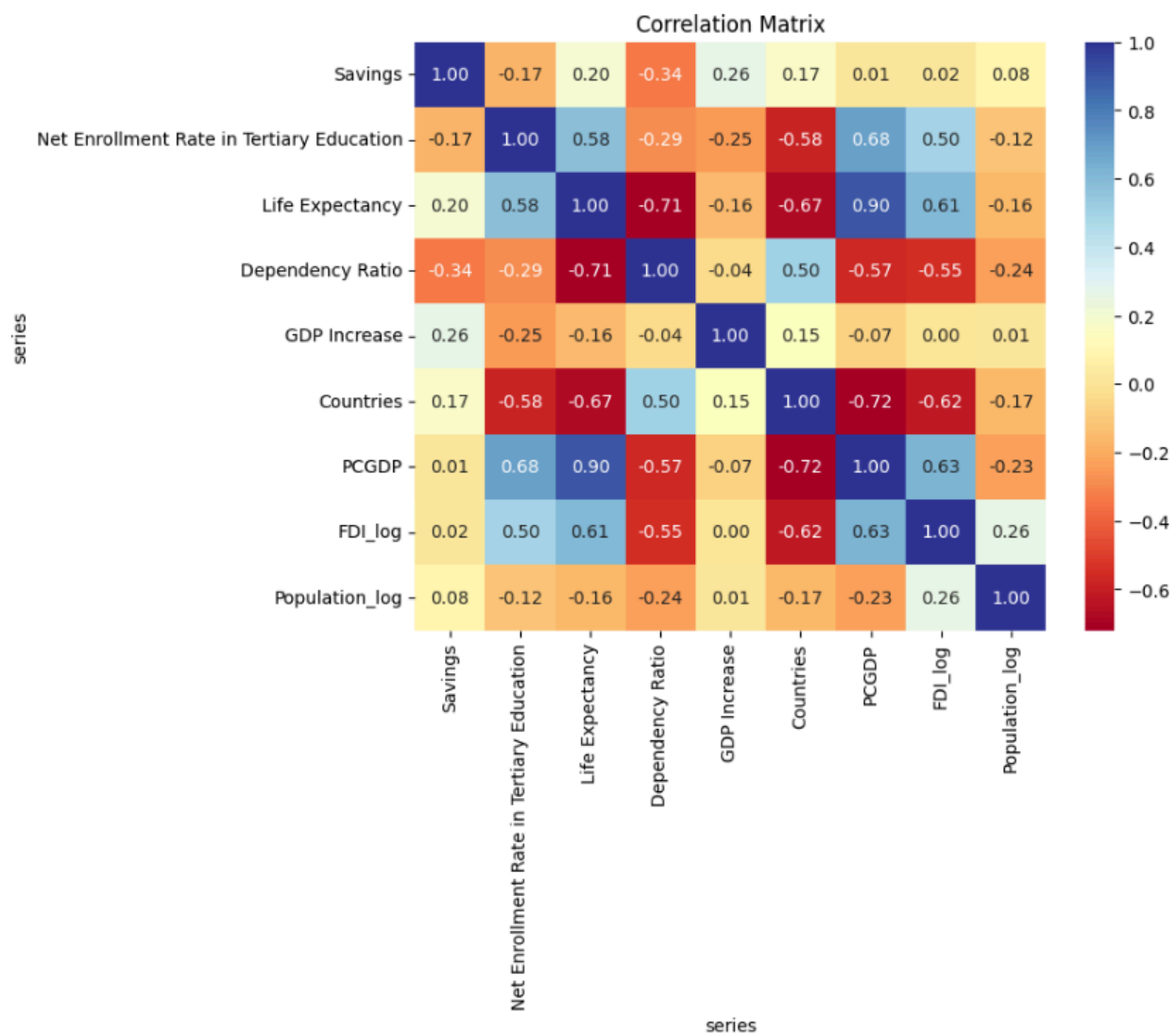
Countries: -0.033:

As explained before this is a categorical feature. A negative value for this coefficient is expected. A value of -0.033 means that category 2 countries have a 0.033 decrease in GDP than category 1 countries (keeping all other variables constant). For example, keeping all other

variables constant, the UK (category 1) would have a higher output of 0.033 than Japan (category 2). The same can be said for other countries from other categories.

Multicollinearity:

The issue of multicollinearity is a huge issue in this regression as all of the variables/features are economic variables that have a high correlation. High correlation between variables themselves can cause an issue of having statistically insignificant weights. A heatmap or a correlation matrix was printed to check the correlation. A value of zero between two variables works best for a regression analysis.



As seen, the correlation values go as high -0.72 and 0.90, indicating a low statistical significance of weights. This can be seen in the low test scores:

Mean Squared Error: 0.7546950802492184; R-squared: 0.2865493819908391

Conclusion

In this assignment, we have taken into account a diverse set of countries (advanced, emerging and resource driven) and a wide range of variables to account for economic growth of the countries. The regression analysis was done based on the equation

Growth rate of GDP = $\alpha + \beta_1$ (FDI) + β_2 (savings ratio) + β_3 (net enrollment in tertiary education) + β_4 (life expectancy) + β_5 (dependency ratio) + β_6 (PCGDP) + β_7 (countries)

The results of it indicate a positive correlation with some variables and a negative correlation for others. The strongest positive correlation was for the PCGDP which is intuitively accurate as countries with higher GDP are stronger economies. Life expectancy has the strongest negative correlation which can be attributed to a decrease in the proportion of the working population. By examining the qualitative reasons for these results and ranking the variables in the order of their correlation, countries can choose to focus on improving the status of these variables and thus contribute to their economic progress.