Economic Development Analysis

QTM350 Final Project

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Introduction

This project analyzes global economic development using data from the World Bank's World Development Indicators, focusing on three key measures: GDP per capita, employment-to-population ratio, and GDP growth, along with a composite metric that uses the aforementioned indicators to find relationships between countries with high average growth rates

Each indicator highlights a different aspect of development—income levels, labor market participation, and economic growth—offering a comprehensive view of how countries evolve over time. We use case studies of the United States, China, and India to illustrate contrasting growth paths, and apply techniques such as Principal Component Analysis (PCA), clustering, forecasting, and SQL-based data cleaning to uncover broader patterns and trends.

Overall, this analysis provides insights into global disparities, regional dynamics, and the challenges and opportunities facing economies worldwide.

Data Description

This data is from the World Bank's World Development Indicators. We will be utilizing a variety of economic development indicators to conduct this analysis. Our main indicators are `GDP per capita`, `employment to population ratio`, and `GDP growth`. We also examine the relationships between these indicators and countries with high average GDP growth rates, aiming to identify patterns and factors associated with sustained economic expansion:

- **`GDP per capita`** represented by the indicator NY.GDP.PCAP.KD, measures a country's economic output divided by its population, adjusted for inflation using constant 2015 US dollars. It reflects the average income or productivity per person and is commonly used as a proxy for a country's standard of living and overall economic development. This data was obtained from the World Bank and spans from 1960 to 2023 for most countries. We

supplemented the GDP data with country-level metadata including country codes and regions, which allowed for comparative and regional analyses across global economies.

The dataset includes annual GDP per capita values for a wide range of countries, enabling longitudinal comparisons and trend analysis. The use of constant dollars helps control for inflation and facilitates meaningful comparisons over time. We focused on three countries—the United States (USA), China (CHN), and India (IND)—to examine contrasting economic trajectories, and we also included clustering and forecasting techniques to further explore global patterns and project future developments.

- **`employment to population ratio`** is a variable that measures the proportion of a country's working-age population that is currently employed. It reflects the share of people aged 15 and older who are participating in the labor market by holding a job. A higher employment-to-population ratio indicates that a larger percentage of the population is contributing to economic production, while a lower ratio suggests that many individuals are either unemployed, not actively seeking work, or otherwise outside the labor force. This metric is critical for understanding the relationship between labor markets and economic development. This variable is named `L.EMP.TOTL.SP.ZS.` and can be found here. For analysis, we also utilized country metadata that contained information on `region`.

In the context of economic development, the employment-to-population ratio serves as an important indicator of how well an economy is utilizing its human resources. A rising ratio typically suggests positive development trends, such as increasing job creation, greater access to employment opportunities, and improved living standards. Economies with consistently high employment-to-population ratios often experience broader economic growth, higher productivity, and reduced poverty rates. Conversely, a low ratio can signal structural problems like weak labor market demand, gender disparities in employment, or a mismatch between skills and job opportunities. Natural resource dependence can also influence this ratio: in countries heavily reliant on oil or mining, wealth may be generated without widespread employment, leading to lower overall participation rates despite high national incomes. Thus, analyzing changes in the employment-to-population ratio over time offers key insights into the inclusiveness and sustainability of economic growth.

- **`GDP growth`** is a variable that captures the annual percent growth of GDP for countries from 1960 to 2023. More specifically, in the World Development Indicators, this variable is named `NY.GDP.MKTP.KD.ZG.` and can be found here. For analysis, we also utilized country metadata that contained information on `region` and `income level`.

Data Analysis

GDP per Capita

The time series analysis of GDP per capita reveals significant differences in the economic development trajectories of the USA, China, and India. The USA shows a consistent upward trend over the past six decades, with only minor dips during economic recessions. Its GDP per capita remains among the highest globally, highlighting its established infrastructure, productivity, and high standard of living.

In contrast, China's GDP per capita remained relatively flat until the 1990s, after which it began to rise exponentially. This reflects the country's rapid industrialization, export-driven growth, and policy reforms that integrated it into the global economy. India's growth has also accelerated in recent decades, though at a slower pace than China's. The data shows a steady increase from the early 2000s onward, indicative of ongoing development, expansion of services, and infrastructure investment.

To explore future trends, we applied a time series forecasting model to project the USA's GDP per capita for upcoming years. While the model suggests continued growth, this projection is subject to uncertainty due to potential global economic fluctuations.

We also conducted a PCA (Principal Component Analysis) and KMeans clustering on GDP per capita data from 2013 to 2023 to identify global development patterns. This dimensionality reduction technique allowed us to visualize economic similarity between countries, revealing three main clusters: high-income economies, emerging markets, and lower-income nations. The clustering results emphasize persistent global inequality in economic output per person, while also identifying convergence among some developing countries.

Together, these analyses offer a multifaceted view of how economies have evolved, diverged, and converged in terms of per capita income, and provide a framework for understanding global economic dynamics and potential future trends.

Employment to Population Ratio

The Employment-to-Population Ratio trends from 1990-2024 (Many too many data points were excluded before 1990, so it did not necessarily make sense to show N/A values) show clear differences across global regions, revealing important insights about labor market dynamics and economic structures. North America and East Asia & Pacific consistently maintain the highest employment-to-population ratios, while the Middle East & North Africa region shows persistently lower levels. A sharp global decline around 2020 reflects the impact of the COVID-19 pandemic, after which most regions partially recovered, although some — particularly Latin America and Europe — continued to lag. Notably, Sub-Saharan Africa exhibits a relatively resilient employment pattern despite ongoing global shocks, likely due to its labor-intensive

informal economy. Overall, the World Average line demonstrates a slow, steady decline over time, highlighting a global trend toward slightly lower labor market participation.

Natural resources play a critical role in explaining these regional differences. Resource-rich economies, particularly those dependent on oil exports such as those in the Middle East and North Africa, often exhibit lower employment-to-population ratios. This reflects the "resource curse," where resource wealth does not translate into widespread job creation due to capital-intensive industries dominating national output. In contrast, regions like Sub-Saharan Africa, heavily reliant on agriculture and mining, maintain higher employment ratios despite lower GDP per capita, driven by the need for broad participation in informal sectors. The relative resilience of East Asia and North America further suggests that diversified economies with strong service and industrial sectors are better positioned to maintain stable employment levels, even during global disruptions. These findings are consistent with research from the World Bank (2021), the International Labour Organization (2020), and Sachs and Warner (1995), which collectively emphasize the importance of economic diversification in sustaining employment growth.

GDP Growth

The next indicator that we are interested in analyzing is GDP growth. In order to analyze this variable, we first did data cleaning using SQLite. We removed unneeded variables, cleaned variable names, and joined our GDP growth indicator with the country metadata. Then, we removed entries where there was no region. This is because the `country_name` column also contained regions, income levels, and world averages and to avoid redundancy with our joined data, we removed it. Lastly, we pivotted the table into a long format where instead of each year having it's own column, there is a year column and then a GDP growth column to capture the percentage of GDP growth for every year. After cleaning was completed, some simple descriptive statistics tables were created using SQLite which can be seen below. After that, python was used to create visualizations to support further analysis. The main questions we were trying to answer through the analysis of GDP growth was how GDP growth had changed over time between different regions and income levels compared to the world average. The code used to complete this analysis is located in the scripts file of this gtihub repository here.

Results and Discussion

GDP per Capita

The time series analysis shows distinct growth patterns across the United States, China, and India. The United States exhibited steady GDP per capita growth, reflecting a mature, innovation-driven economy with resilience to economic shocks. China's GDP per capita

remained low until the 1990s, after which it surged rapidly, illustrating the impact of industrialization and economic reforms. India's growth, though positive, has been more gradual, suggesting ongoing development alongside persistent structural challenges.

PCA and KMeans clustering from 2013–2023 revealed clear groupings of countries by income levels, with the U.S. among the high-income cluster, China moving upward toward middle-to-high income status, and India situated within a growing but still lower-income group. These patterns highlight both persistent global inequality and emerging convergence trends among developing economies.

The GDP per capita forecast for the U.S. projects continued growth, although uncertainties remain. Together, the results demonstrate the varying trajectories of national economic development and underscore the importance of sustained policy efforts to support inclusive growth.

Employment to Population Ratio

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use_inf_as_na option is deprecated and will be removed in a future version. Convert inf value

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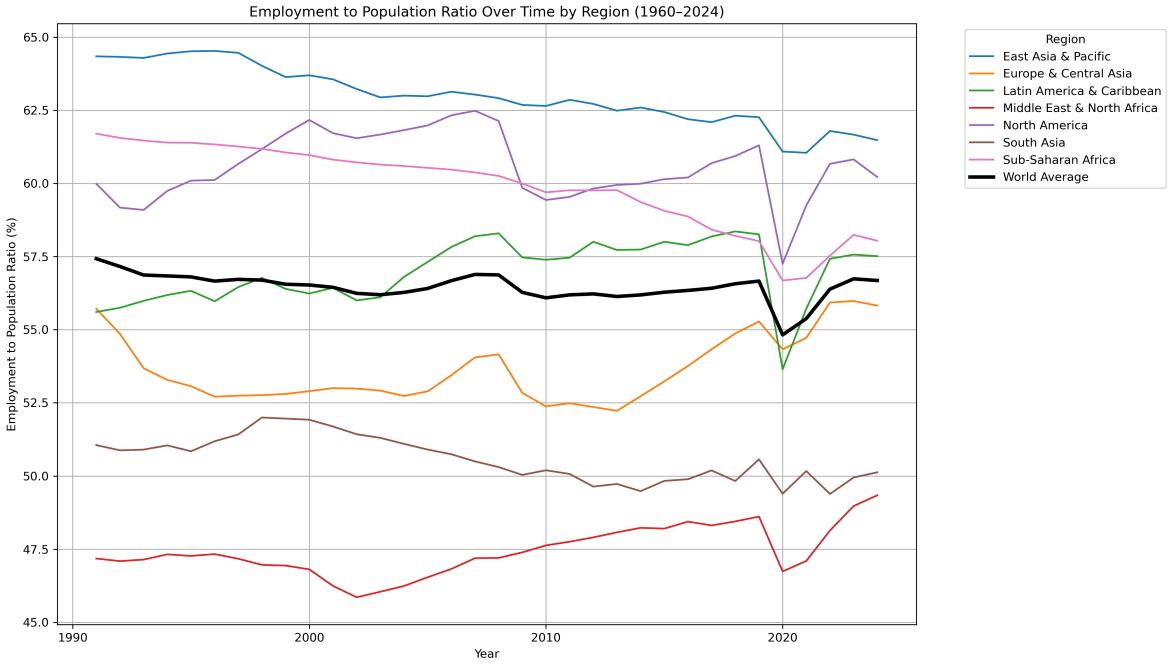

GDP Growth

Here are the results from the GDP Growth analysis.

The table below summarizes GDP growth statistics across decades.

	decade	count_growth	min_growth	avg_growth_decade	max_growth
0	1960s	1026	-27.270000	5.461588	81.887797
1	1970s	1423	-46.433035	4.997033	76.620155
2	1980s	1663	-42.451118	2.991529	34.600001
3	1990s	1942	-64.047107	2.897831	149.972963
4	2000s	2033	-36.656780	4.039469	63.379875
5	2010s	2093	-50.338515	3.183693	86.826748
6	2020s	819	-54.336155	2.009832	75.061377

The 1960s exhibited the highest average GDP growth (~5.46%), while 2020 to present had the lowest average (~2.00%) across the world. The 1990s showed notable volatility with the widest range in growth rates (-64% to +150%). This pattern highlights a long-term slowdown of global economic expansion over the past six decades.

The table below summarizes GDP growth by world region.

	region	n_countries	n_obs	avg_growth	min_growth	max_growth
0	East Asia & Pacific	36	1828	3.788046	-54.336155	75.061377
1	Europe & Central Asia	57	2558	2.876755	-44.899775	54.199300
2	Latin America & Caribbean	41	2157	3.219749	-26.782933	63.334587
3	Middle East & North Africa	21	1098	4.927993	-64.047107	86.826748
4	North America	3	189	2.818637	-6.842870	14.363636
5	South Asia	8	442	5.054728	-32.908829	37.507870
6	Sub-Saharan Africa	48	2727	3.825631	-51.030865	149.972963
7	World	1	63	3.783984	-5.108132	6.392297

When broken down by region, the Middle East and North Africa had the highest average GDP growth (~4.93%) compared to other world regions from 1960 to 2023. This is likely due to oil wealth and energy exports in this region. North America had the slowest average growth (~2.82%) during this time period. This is consistent with trends observed in developed economies with mature markets and slower population growth. The variabiltiy seen across regions suggest that resource wealth, political stability, and demographic factors strongly influence long-term GDP trajectories.

The table below summarizes GDP growth by income group.

	income_group	n_countries	n_obs	min_growth	avg_growth	max_growth
0	Upper middle income	54	2813	-64.047107	4.040969	149.972963
1	Lower middle income	51	2731	-46.433035	3.876785	58.078096
2	World	1	63	-5.108132	3.783984	6.392297
3	Low income	25	1333	-51.030865	3.368783	106.279814
4	High income	83	4068	-54.336155	3.255113	82.809329

Among income groups, Upper Middle Income countries experienced the highest average growth (~4.04%) from 1960 to 2023, while High Income countries had lower average growth (~3.26%) during this time period. The Upper Middle Income country growth reflects the rapid industrialization and modernization of economies such as China, Malaysia, and Turkey from 1960 to 2023. The more stable, lower growth experienced by High Income countries reinforces the idea that as economies mature, growth rates naturally slow. This comparison shows the importance of the development stage in driving economic performance across countries.

This first figure displays average GDP growth over time by region.

While short-term fluctuations are common across the globe, a general decline in growth rates is observed post-1970s across most regions. It is clear on the figure that all world regions experienced high short-term volatility, especially Sub-Saharan Africa and South Asia, with many regions experiencing sharp dips around known global recessions (i.e. the early 1980s and

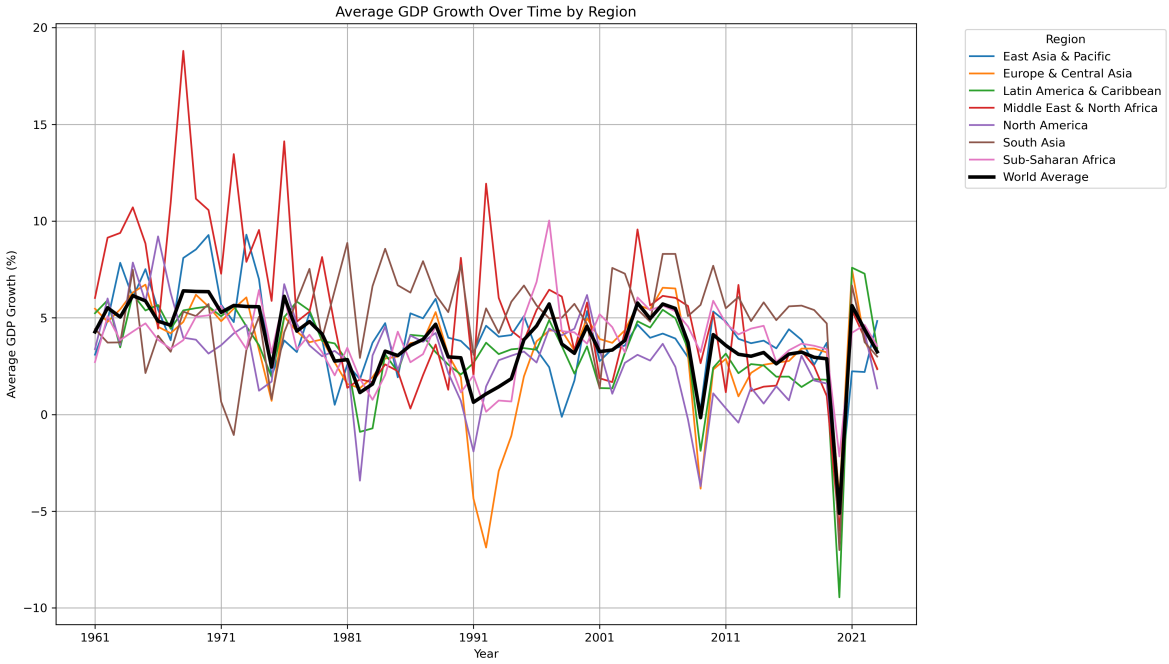

Figure 1

late 2000s). The world average (thicker black line) remains relatively stable compared to the volatility shown in other regions, with spikes and dips corresponding to major global events. The world average also demonstrates how the global economy exhibits greater resilience and inertia compared to individual regions.

The second figure presents a smoothed trend line of GDP growth over time by world region.

This reveals a clearer long-term downward trend of GDP growth across all regions in the world. Notably, Sub-Saharan Africa, the Middle East and North Africa, and South Asia initially experienced relatively high growth, but later their growth rates converged downward with other regions. North America and Europe and Central Asia have shown the lowest growth decline trajectory so far. This is likely explained by structural factors, such as aging populations, slower technological diffusion, and diminishing returns to capital.

The below figure displays the average GDP growth over time by country income level.

This income group graphs show that GDP growth trends differ substantially across income levels. High-income countries experienced relatively stable and moderate growth throughout the observed period, with smaller fluctuations even during major global events such as the 2008 financial crisis and the 2020 pandemic. In contrast, lower-middle-income and low-income countries exhibited much greater volatility, with sharp downturns during periods of global recession. Upper-middle-income countries generally achieved higher average growth rates, particularly during the 1990s and early 2000s, but their growth also became less consistent after

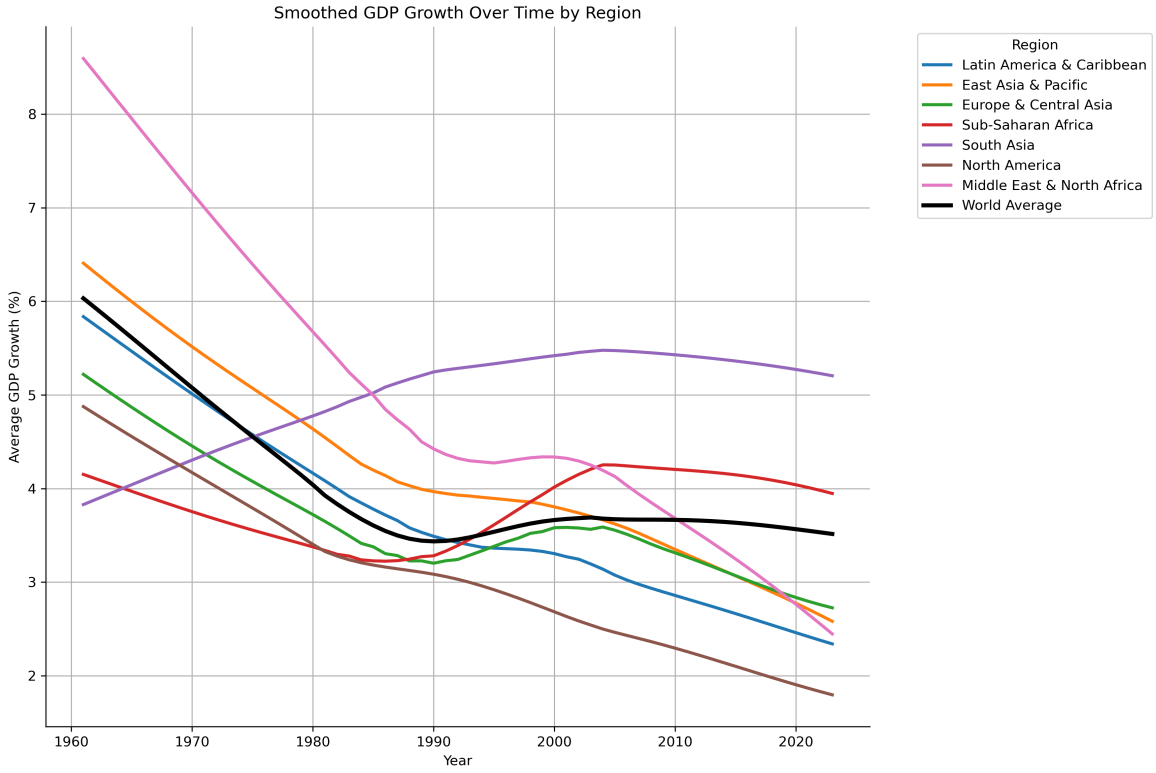
Smoothed GDP Growth Over Time by Region
Average GDP Growth (%)
Year
1960
1970
1980
1990
2000
2010
2020
2
3
4
5
6
7
8
Region
Latin America & Caribbean
East Asia & Pacific
Europe & Central Asia
Sub-Saharan Africa
South Asia
North America
Middle East & North Africa
World Average

Figure 2

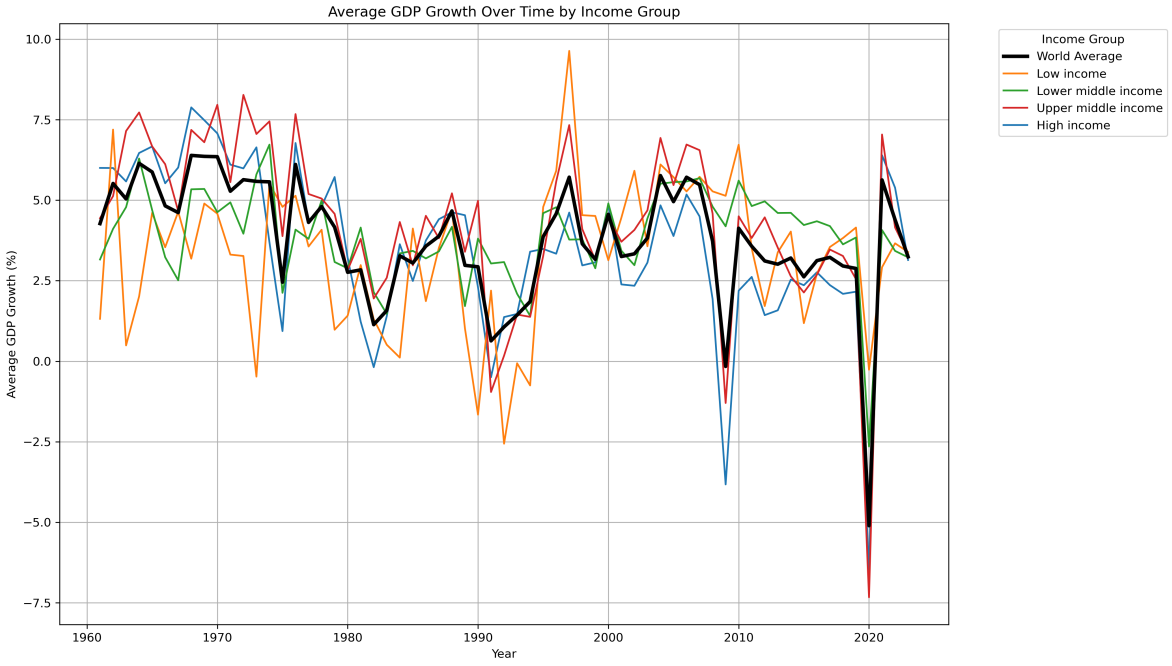

Figure 3

2008. These patterns suggest that lower-income countries are more vulnerable to external shocks, while high-income countries are more insulated due to stronger economic institutions and diversification.

This last figure presents a smoothed trend line of GDP growth over time by country income level.

The smoothed income group trends highlight longer-term structural shifts in global GDP growth patterns. Across all income groups, there is a visible gradual decline in average growth rates from the 1960s to the 2020s. Although upper-middle-income countries reached a peak of growth around the early 2000s, this momentum slowed considerably in the following decades. Low-income countries experienced the steepest long-term decline, pointing to persistent challenges such as political instability, lack of infrastructure, and dependency on a narrow range of industries. High-income countries maintained steadier growth but at increasingly lower rates over time, suggesting that mature economies are facing limits to expansion. Together, these smoothed trends imply that broader global factors, such as technological stagnation, demographic shifts, and environmental pressures, are influencing growth trajectories across all income levels, albeit unevenly.

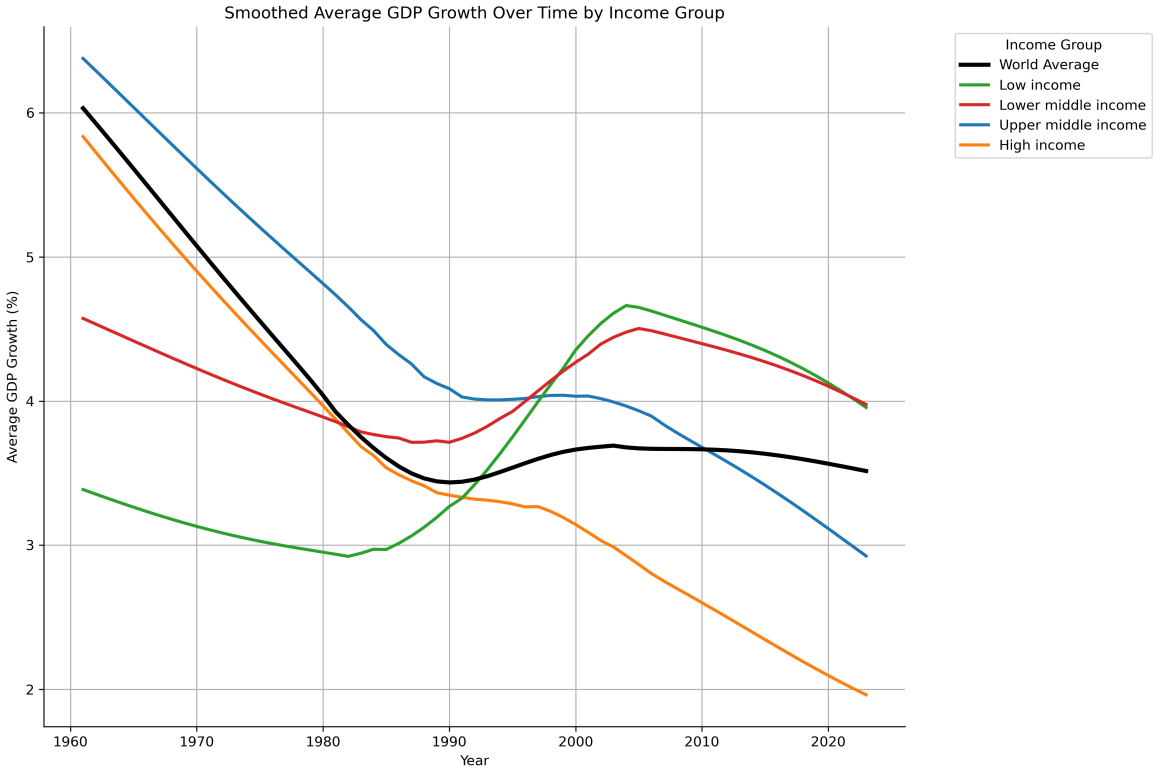
Smoothed Average GDP Growth Over Time by Income Group
Average GDP Growth (%)
Year
Income Group
World Average
Low income
Lower middle income
Upper middle income
High income

Figure 4

Identifying Drivers of Sustained Economic Growth: An Analysis of High-Performing Economies

In addition to looking at global GDP growth, we aim to identify factors that contribute to the highest sustained economic growth. We will measure economic growth by examining the percentage increase in GDP over time and focus our analysis on the top five countries with the highest growth rates.

	Country Name	Average_Rank
40	China	16.029412
257	Viet Nam	42.470588
160	Myanmar	44.588235
261	Kosovo	51.562500
129	Lao PDR	57.911765

These 5 highest countries are China, Viet Nam, Myanmar, Kosovo and Lao PDR. Let us put htem up on a graph to show their relationship over time

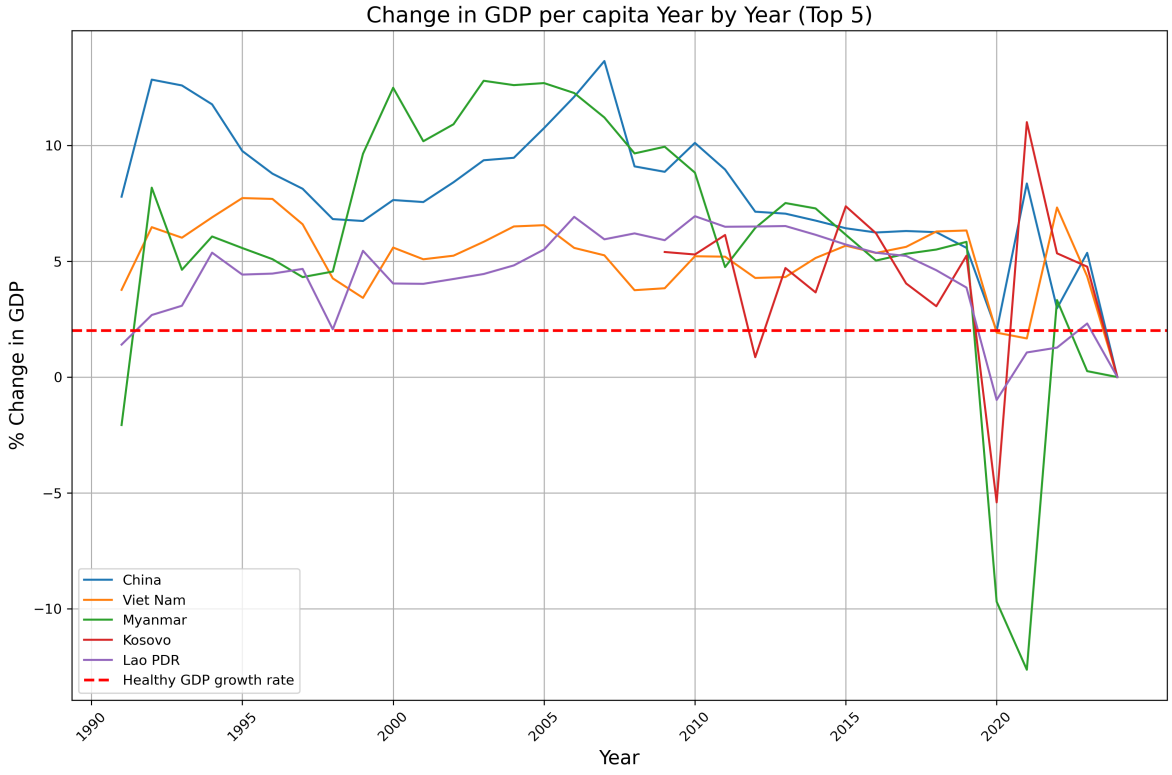

Figure 5

Economists state that a health gdp growth rate is 2% we see that on average, our top 5 countries are always above the average, excluding the huge drop during COVID.

Let us see if we can find any meaningful connections between these coutnries when looking at percent of Export and Imports as a portion of GDP

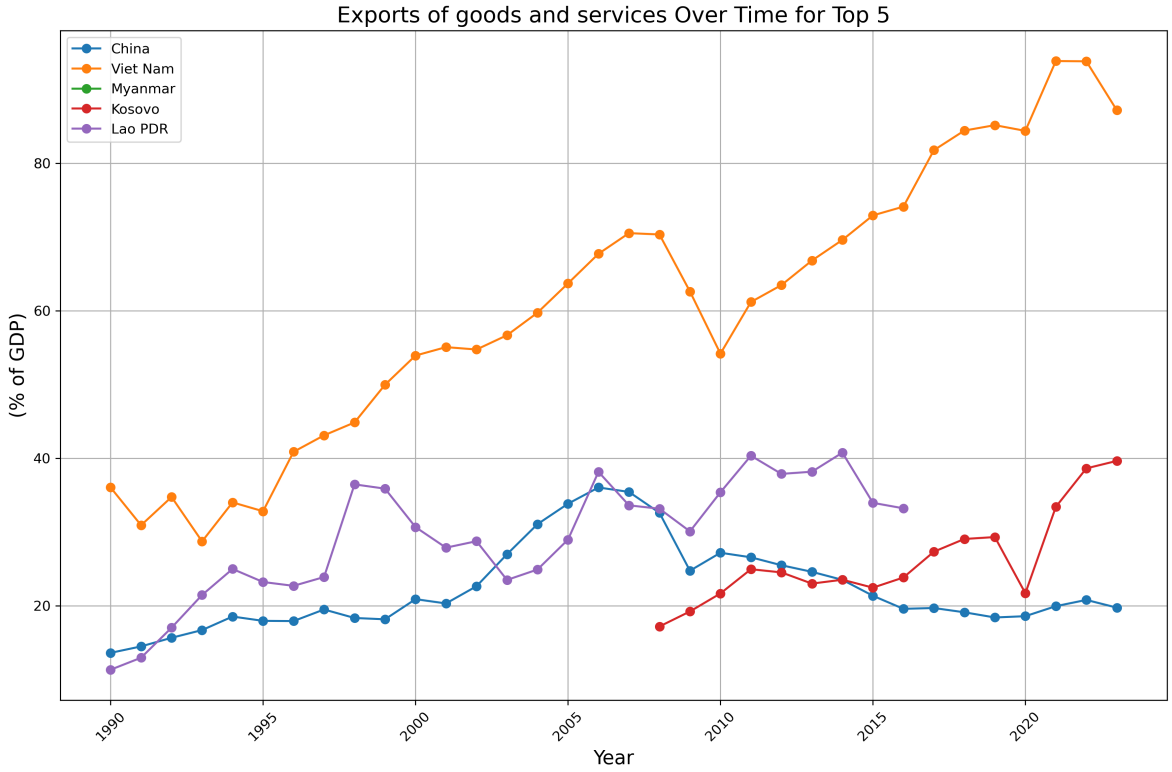

Figure 6

When looking at the percentage of GDP made up by exports and imports, we see a clear difference between China, Vietnam, Myanmar, Kosovo, and Lao PDR. This variation highlights how trade can be a powerful tool for economic growth. By expanding exports, countries can generate more income, create jobs, and bring in foreign currency, which can be reinvested into infrastructure, education, and technology. Similarly, imports allow countries to access goods, services, and technology that they do not produce themselves, helping to improve productivity and competitiveness. For example, Vietnam has aggressively expanded its export sector over the past three decades by integrating into global supply chains, especially in electronics, textiles, and manufacturing. This strategy has helped Vietnam achieve rapid economic growth, reduce poverty, and transition from a primarily agricultural economy to one focused on industry and services. In contrast, China used trade as a major driver of its economic rise by becoming the "world's factory," exporting a vast range of manufactured goods while simultaneously importing raw materials and high-tech equipment to fuel its industrial expansion.

Even smaller economies like Kosovo have used trade to stimulate growth. By opening its markets and increasing exports, especially in sectors like metals, textiles, and services, Kosovo has worked to create more job opportunities and strengthen its economy, even though challenges remain. In short, we see that our countries have successfully used exports and imports to connect with the global economy which contributed to faster GDP growth.

Speaking on GDP growth, let us look at and compare the nominal GDP growth for each of the countries, and see if there are any meaningful relationships there.

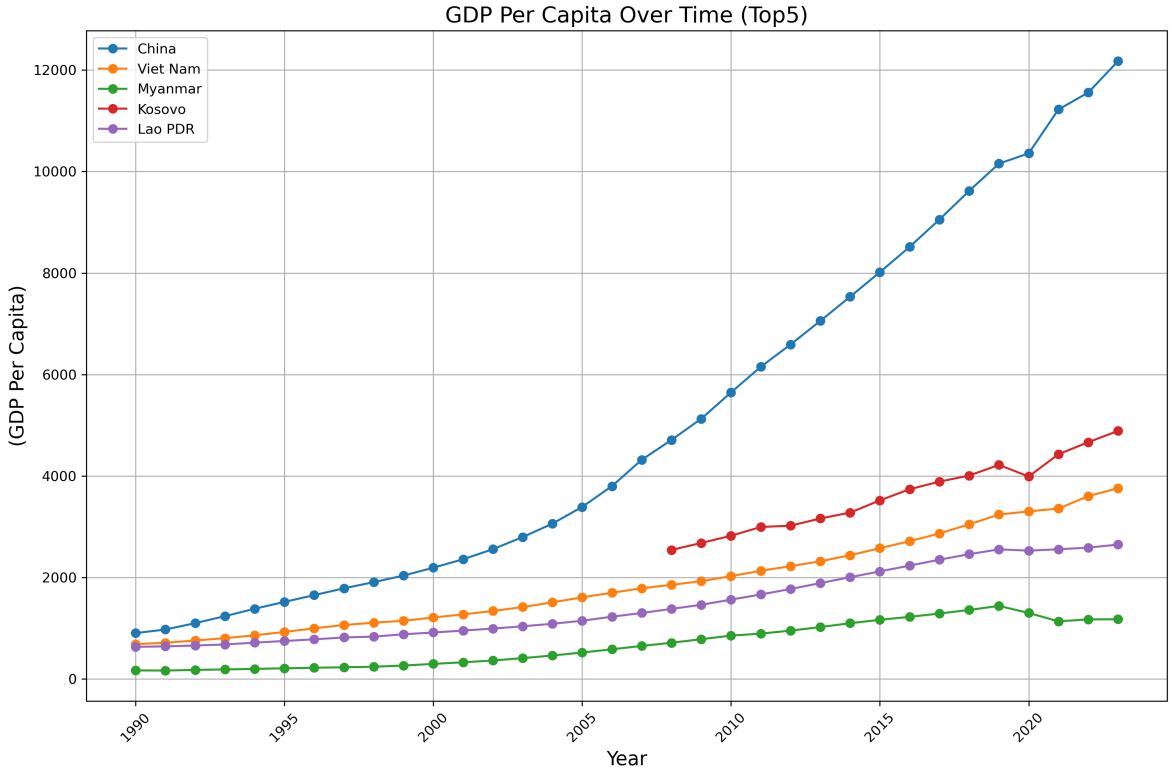

Figure 7

The graph presented examines nominal GDP per capita over time to assess the economic growth trajectories of our top five countries. By focusing on nominal GDP per capita, the graph aims to provide a clearer understanding of each country's initial economic position and how it evolves over time. Upon review, we observe that there is little correlation between the starting GDP per capita of the countries, as they begin at different levels yet still experience significant economic growth. While the goal was to explore the influence of initial economic conditions on long-term growth patterns, the results do not strongly support this hypothesis. Instead, it becomes apparent that the varying starting points in capital across the countries did not seem to hinder their ability to achieve high rates of growth.

Let us now go onto to look at the relationship between employment percentages

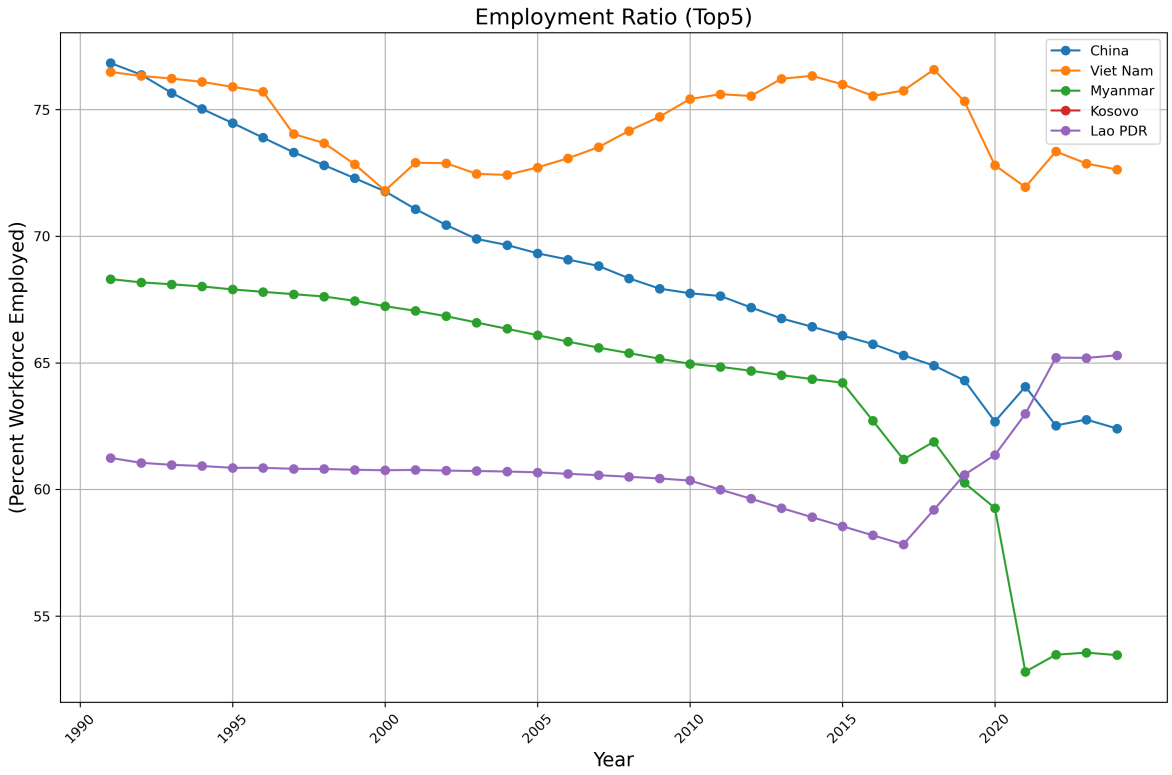

Figure 8

Across China, Vietnam, Myanmar, Kosovo, and Lao PDR, employment ratios show some common patterns alongside important differences. In general, countries that have embraced export-led growth strategies, industrialization, and international trade tend to have higher employment ratios and have created more formal job opportunities. Meanwhile, countries that remain heavily dependent on agriculture or have less diversified economies often experience lower employment ratios, with a larger share of workers engaged in informal or subsistence activities. Focusing specifically on Vietnam and Lao PDR highlights these trends clearly. Vietnam has maintained a high employment ratio, thanks to its rapid industrialization and integration into global markets. Since the 1990s, Vietnam's shift from a primarily agricultural economy to a manufacturing and services-driven one has created millions of jobs in factories, technology firms, and export-oriented industries. Trade agreements with major partners like the United States, the European Union, and neighboring Asian countries have further boosted employment by attracting foreign investment and expanding Vietnam's access to global markets. In contrast, Lao PDR has a much lower employment ratio. Although Laos has also experienced economic growth, much of its labor force remains tied to agriculture, often in informal or subsistence roles. Industrial and manufacturing sectors are smaller, and trade is

less diversified, limiting the number of formal job opportunities available. While sectors like hydropower and mining have driven some growth, they tend to be capital-intensive rather than labor-intensive, meaning they generate fewer jobs relative to their economic output. Despite these differences, all five countries have maintained relatively high GDP growth rates in recent years. Strong employment growth, especially in Vietnam, has played a key role by boosting domestic demand, increasing household incomes, and enabling broader participation in the economy — all of which help sustain and accelerate economic expansion.

Conclusion

This analysis of GDP per capita, employment-to-population ratio, and GDP growth across countries and regions offers a comprehensive view of global economic development over the past several decades. Through time series analysis, clustering, and forecasting, we identified distinct growth trajectories among nations like the United States, China, and India, highlighting both persistent inequalities and signs of economic convergence. The employment-to-population ratio further revealed key differences in labor market participation, often shaped by structural factors such as resource dependence and economic diversification. Lastly, our study of GDP growth trends showed a broad decline in growth rates since the 1960s, with higher volatility and vulnerability among lower-income countries, and slower, steadier growth in high-income economies.

Together, these findings underscore the importance of inclusive, sustainable policies that support long-term development. While some emerging economies are rapidly catching up, global disparities in income, employment, and resilience to economic shocks remain significant. Monitoring these indicators over time provides valuable insight into the evolving challenges and opportunities facing the world economy.