Empirical Examination of Absolute Convergence Hypothesis

Amit Kr Eshore

24msceco01

Contents

1 Introduction

This report empirically examines the absolute convergence hypothesis, which predicts that economies converge to a common income per capita level, with poorer countries growing faster. This is typically tested by observing a negative correlation between initial income and subsequent growth.

Using Penn World Table (PWT) and World Bank (WDI) data from 1985-2019, this study analyzes income convergence across low, middle, and high-income countries, dividing the period into 1985-2000 and 2000-2019 to assess changes in convergence dynamics.

The research also investigates convergence in national investment rates, measured as Gross Capital Formation (GCF) as a percentage of GDP, to understand the drivers of income convergence, as capital formation is key to economic growth. Analyzing the relationship between investment and income patterns provides insights into persistent global economic disparities. Through econometric analysis, this research contributes to the debate on whether market forces reduce or worsen international economic inequality.

For all the regression and all the analysis **Python** is extensively used. The code for the same has been attached.

2 Part A: Test of Absolute Convergence of Growth Rate Using GDP per capita

2.1 PART I: Methodology

2.1.1 A1: Downloading the data

The data has been downloaded from the PWT. The ”Expenditure-side real GDP at chained PPPs (in mil. 2017US$)” and the ”population data” of all the available countries are downloaded for the time period 1950 to 2021.

2.1.2 A2: Choosing the time period

We are interested in the data of all those countries whose time series data for the period 1985 to 2019 has no missing values. For that I have only kept those countries whose data for expenditure side real GDP at chained PPP is available for all the time frames.

2.1.3 A3: Exclude oil exporters (Oil exports to GDP ratio ¿ 80%) and countries with population of less than 1 million

To find out the name of countries I have used **WDI data.** The indicator **Merchandise exports (% of GDP) and Fuel Exports (% of Merchandise Export)** are used.

$$\text{Oil Export to GDP (\%)} = \frac{\text{Fuel Exports (\% of Merchandise Exports)} \times \text{Merchandise Exports (\% of GDP)}}{100}$$

Figure 1: Fuel exports as percentage of GDP

There are 16 countries whose share in the fuel exports are greater than 80 percent of the GDP. Among those 16 countries only 10 has more than 1 million population.

2.1.4 A4: Classifying the countries into three groups

For classification into three groups I have used the paper by World Bank[2]. The paper mentioned the PPP level of high income countries as GDP per capita at PPP greater than 10000 USD. For medium income countries it should be between 3000 to 10000 USD. For low income countries it is lower than 3000 USD.

2.1.5 A5: Growth rate calculation

Growth rate is calculated using the following formula:

$$\text{growth rate} = \ln(k_t) - \ln(k_{t-1}) \tag{1}$$

Calculated three different growth rate corresponding to whole time frame first period and second.

2.2 PART II : Regression Results and Economic Interpretation :

2.2.1 A6: Test for convergence hypothesis

For testing the convergence hypothesis we use the following econometrics model:

$$AGR_t = \alpha + \beta_1 RGDPPC_t + \epsilon_t \tag{2}$$

where AGR_t denotes the average growth rate for the time frame and AY_t denotes the real per capita GDP at the base year for the regression. If the coefficient of the $RGDPPC$ is negative then we say that the countries are supporting the absolute convergence hypothesis. In other words as the per capita real GDP (PPP) increases the growth rate decreases given the sign of β_1 is negative.

2.2.2 A7: OLS Regression Results and estimation

Here we run regression of growth rate for all time period given by All Time, 1985-2000 and 2000-2019 and also then grouping data set into three different household type namely high, medium and low income.
Note: Here all the *** shows the significance at 1 percent level, ** for significance at 5 percent level and * for significance at 10 percent level.

Table 1: Regression Results for GDP per capita convergence

Type		All Time	1985-2000	2000-2019
All Types (89)	const	0.8267*** (0)	0.2069*** (0)	0.6198*** (0)
	independent	-1.71e-06 (0.784)	1.089e-05** (0.011)	-1.26e-05*** (0.001)
	adj.r-square	-0.011	0.062	0.109
	convergence	yes	no	yes
High (27)	const	0.9863*** (0)	0.4811** (0.011)	0.4742*** (0.004)
	independent	-9.396e-06 (0.365)	-1.42e-06 (0.858)	-4.08e-06 (0.347)
	adj.r-square	-0.006	-0.039	-0.003
	convergence	yes	yes	yes
Medium (32)	const	0.5706* (0.062)	0.1928 (0.404)	0.4604*** (0.000)
	independent	4.878e-05 (0.345)	2.182e-05 (0.584)	7.853e-06 (0.499)
	adj.r-square	-0.003	-0.023	-0.017
	convergence	no	no	no
Low (30)	const	0.4638 (0.163)	0.0160 (0.928)	0.3439** (0.014)
	independent	0.0002 (0.265)	8.454e-05 (0.366)	0.0001** (0.015)
	adj.r-square	0.010	-0.005	0.166
	convergence	no	no	no

2.2.3 A8: Economic Interpretation

Neoclassical Growth Theory and Convergence Mechanisms

Conditional β-convergence: The Solow model predicts that poorer economies grow faster than richer ones if they share similar structural characteristics (e.g., savings rates, population growth, technology). This is captured by the equation:

$$y_i = \alpha + \beta \times (\text{Initial GDP per capita})_i + \epsilon_i \tag{3}$$

where y_i is the average growth rate between the time period.

A negative coefficient (β) for initial income indicates convergence.

The results for all 89 countries reveal different patterns: A negative coefficient (β) for initial income indicates convergence. The results for all 89 countries reveal different patterns:

- **Full Period**: No statistically significant convergence or divergence is observed across the entire timeframe. Although convergence is observed supporting that country wide inequality is decreasing.
- **1985-2000**: A statistically significant positive coefficient (5%) indicates **divergence**, where richer countries grew faster than poorer ones, increasing income inequality.

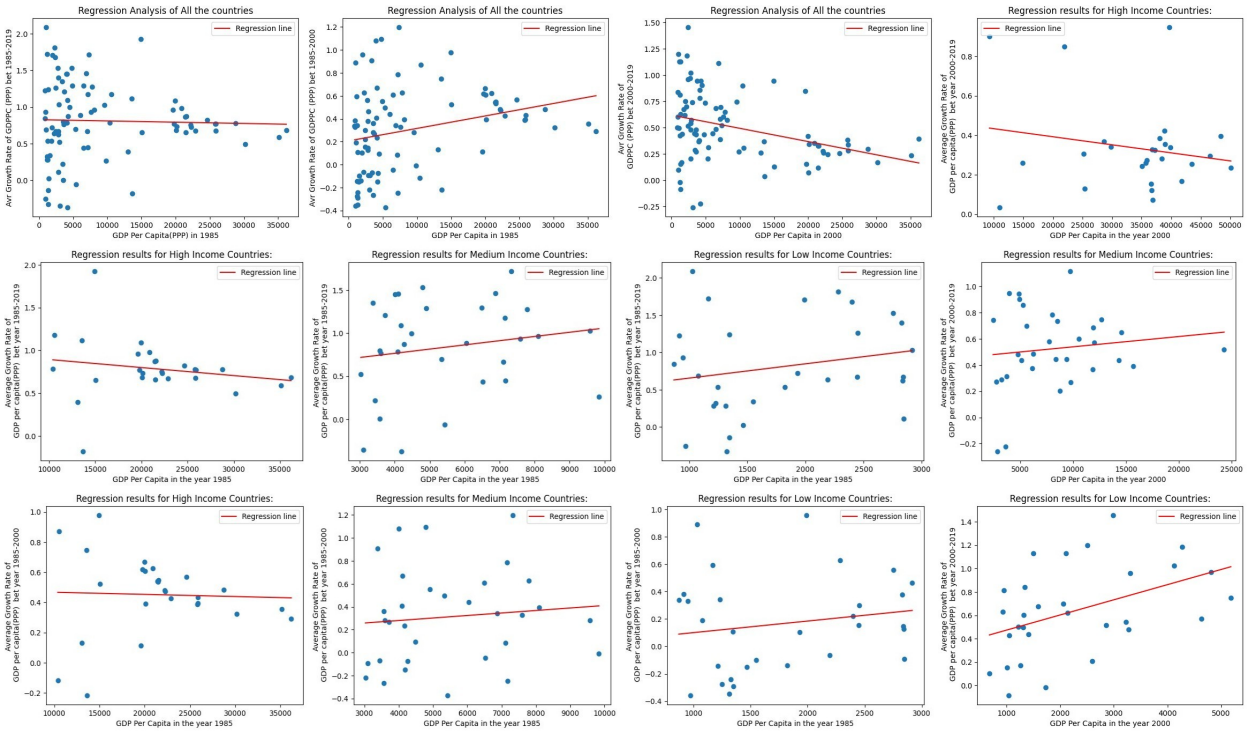

Figure 2: Regression plots for growth rate of GDP per capita convergence

- **2000-2019**: A highly statistically significant negative coefficient suggests **absolute convergence**, with poorer countries growing faster than richer ones, potentially reducing income inequality. This may be due to rapid adoption to technology and technology transfer post globalization period.

Breaking down by income groups reveals following patterns:

- **High-Income Countries (27)**: No significant relationship between initial income and growth in any period, suggesting these economies have reached similar steady states with no systematic convergence among them.
- **Medium-Income Countries (32)**: Similar to high-income countries, no significant pattern emerges. All coefficients are positive but insignificant, with very low explanatory power (negative adjusted R-squared values).
- **Low-Income Countries (30)**: While showing no significant pattern in earlier periods, the 2000-2019 period reveals a positive and significant coefficient (0.0001, p=0.015). This indicates *divergence within the low-income group* - the relatively better-off among poor countries grew faster, widening intra-group inequality. This period also shows the highest adjusted R-squared (0.166) of any group-period combination.

3 Part B: Test of Absolute Convergence of Gross Capital Formation as a Percentage of GDP

3.1 B1: Using GCF as a Percentage of GDP

Convergence in gross capital formation (GCF) as a percentage of GDP suggests that countries with lower initial investment rates tend to experience faster growth in their investment-to-GDP ratio compared to those with higher initial rates. A negative coefficient on GCF as a percentage of GDP would indicate a "catching-up" phenomenon. This convergence can be driven by policies promoting investment, foreign investment inflows, and technology transfer.
The regression equation is given by:

$$g_i = \alpha + \beta \times k_i + \epsilon_i \tag{4}$$

Where g_i represent the average growth rate of gross capital formation as a percentage of GDP for observation i (Time frame), and let k_i represent the gross capital formation as a percentage of GDP for observation i (Base time).

Table 2: Regression Results for GCF convergence

Type		All Time (1985-2019)	1985-2000	2000-2019
All Countries (89)	const	0.5224*** (0.000)	0.8729*** (0.000)	0.2456 (0.063)
	GCFPGDP	-0.0209*** (0.000)	-0.0412*** (0.000)	-0.0049 (0.382)
	adj.r-square	0.379	0.444	-0.003
	convergence	yes	yes	yes
High Income (27)	const	0.5601* (0.055)	1.4730*** (0.000)	1.3203 (0.076)
	GCFPGDP	-0.0229* (0.051)	-0.0623*** (0.000)	-0.0540 (0.083)
	adj.r-square	0.110	0.647	0.080
	convergence	yes	yes	yes
Middle Income (32)	const	0.4451*** (0.002)	0.5012** (0.043)	0.7061*** (0.002)
	GCFPGDP	-0.0188*** (0.004)	-0.0231** (0.040)	-0.0296*** (0.003)
	adj.r-square	0.225	0.104	0.229
	convergence	yes	yes	yes
Low Income(30)	const	0.5613*** (0.000)	0.9048*** (0.000)	0.7911*** (0.000)
	GCFPGDP	-0.0207*** (0.000)	-0.0470*** (0.000)	-0.0256*** (0.008)
	adj.r-square	0.556	0.576	0.201
	convergence	yes	yes	yes

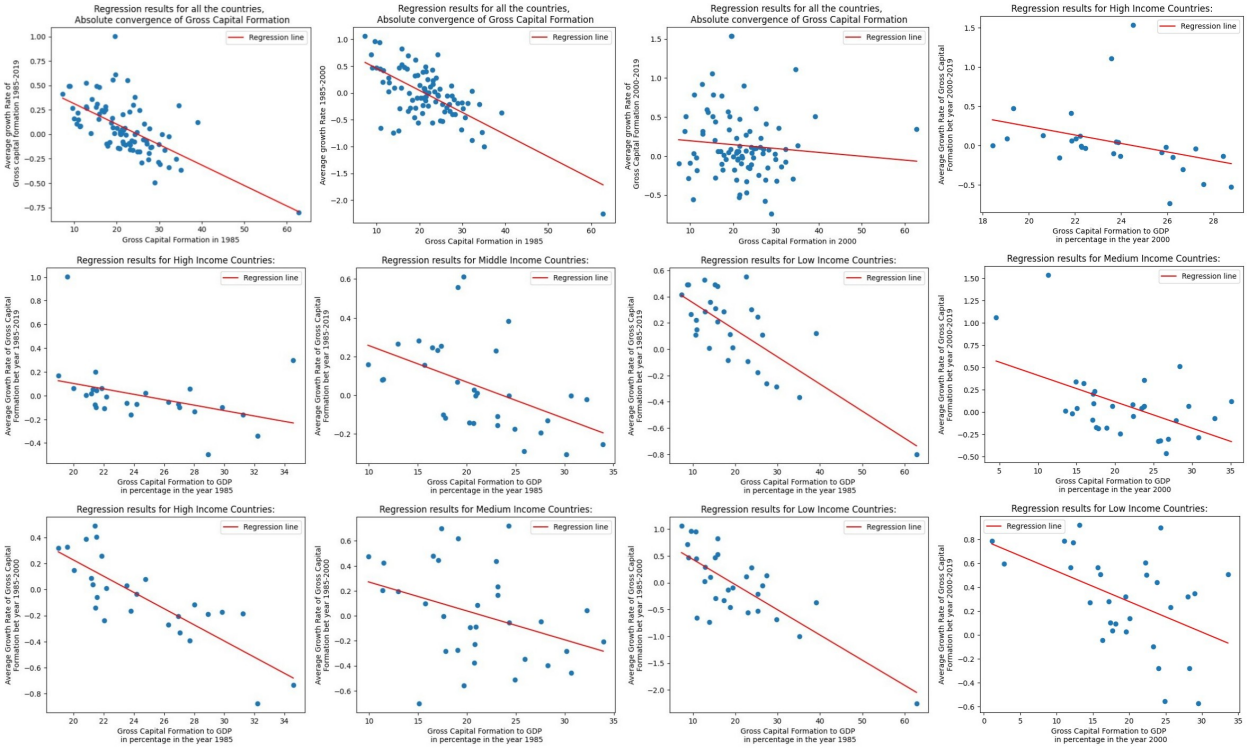

Figure 3: Regression plots for GCF convergence

As the results suggest, there is absolute convergence in gross capital formation as a percentage of GDP; implies that countries with initially lower investment rates; typically poorer nations, experience faster growth in their investment relative to their GDP.

3.2 B2: Comparison Between Two Approaches

As we can see from the table the convergence in investment rate in the country across all time frame is significant. And in the 2000-2019 period absolute convergence is there and is statistically significant. So it can be concluded that convergence in investment rates is usually accompanied by convergence in income. Convergence in investment rates and incomes often occurs together as countries develop economically. As nations grow wealthier, they tend to invest more in capital goods and infrastructure, which can lead to increased productivity and higher incomes. We can attribute the convergence in incomes partly to convergence in investment rates.

4 Bibliography

1. Barro, Robert J., and Xavier Sala-i-Martin. *Economic Growth*. McGraw-Hill, 1995. (Foundational text on convergence theory and empirical growth analysis.)

2. Mankiw, N. Gregory, David Romer, and David N. Weil. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics*, vol. 107, no. 2, 1992, pp. 407-437. (Seminal paper linking capital accumulation and growth, relevant for investment rate analysis.)

3. Penn World Table (PWT) Version 10.0. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. (Primary data source for GDP and population data used in your analysis.)

4. World Bank Development Indicators. The World Bank Group. (Another key data source for economic indicators.)

5. Islam, Nazrul. "Growth Empirics: A Panel Data Approach." *Quarterly Journal of Economics*, vol. 110, no. 4, 1995, pp. 1127-1170. (Panel data approach to convergence testing, useful methodological reference.)

6. Durlauf, Steven N., Paul A. Johnson, and Jonathan R. Temple. "Growth Econometrics." In *Handbook of Economic Growth*, edited by Philippe Aghion and Steven N. Durlauf, Elsevier, 2005, pp. 555-677. (Comprehensive review of growth econometrics and convergence literature.)

7. `https://mospi.gov.in/sites/default/files/reports_and_publication/statistical_manual/Chapter%2025.pdf`

8. `https://unstats.un.org/Unsd/methods/icp/gdp/gdp02_htm.htm`

Appendix

Oil Exporting (¿80% of GDP) countries excluded: Angola, United Arab Emirates, Azerbaijan, Bahrain, Bahamas, Brunei, Congo, Gabon, Iraq, Kuwait, Libya, Oman, Qatar, Singapore, Turkmenistan, Trinidad and Tobago.

Table 3: Country Classification by Income Group

High Income Country	Medium Income Country	Low Income Country
Switzerland	South Africa	Philippines
United States	Turkey	Senegal
Canada	Uruguay	Ghana
Norway	Malaysia	Honduras
Sweden	Costa Rica	Indonesia
Australia	South Korea	Sri Lanka
Denmark	Ecuador	Bolivia
Netherlands	Mauritius	Pakistan
France	Colombia	Mongolia
United Kingdom	Panama	China
Finland	Namibia	Kenya
Germany	Chile	Egypt
Italy	Brazil	Sudan
Belgium	Nicaragua	Benin
Austria	Tunisia	Togo
New Zealand	Dominican Republic	Madagascar
Japan	Argentina	Niger
Hong Kong	Paraguay	Bangladesh
Israel	Jordan	Central African Republic
Saudi Arabia	Zimbabwe	Sierra Leone
Greece	Peru	Rwanda
Ireland	Thailand	Guinea-Bissau
Algeria	Jamaica	Chad
Spain	Botswana	India
Mexico	Albania	Burkina Faso
Portugal	Morocco	El Salvador
Bulgaria	Guatemala	Burundi
	Cameroon	Mali
	Mauritania	Nepal
	Iran	Uganda
	Gambia	
	Côte d'Ivoire	