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Does Cross-Country Income Convergence Occur?

Ahmad Thoifur [a,1,*]

[a] Universitas Indonesia, Indonesia
[1] ahmad.thoifur12.7001@gmail.com
* corresponding author

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ABSTRACT

Income is one of the most popular dimensions for measuring welfare and development; hence, comparing welfare and well-being among countries can be conducted by comparing their per capita income. While income convergence is a certain implication in neoclassical growth theory, it does not always occur empirically. This study aims to investigate whether income convergence occurs among economies. Employing data from 93 countries from 1980 to 2022 obtained from the World Bank, the two-way fixed effect panel model is implemented to verify the existence of β-convergence. The result shows that the initial per capita gross domestic product, representing income, negatively affects income growth, indicating that β-convergence occurs in terms of global and club convergence. This implies that poor countries grew faster than affluent countries. After β-convergence is confirmed, σ-convergence is analyzed by measuring the income dispersion across countries over time. σ-convergence exists if the dispersion declines as time passes. The result shows that σ-convergence exists only among G20, OECD, lower-middle-income, higher-middle-income, and high-income countries. This fact implies that the income gap between poor and rich countries within those groups shrinks over time. In contrast, the income gap among low-income countries did not experience a significant decline during the period. Therefore, international organizations and partnerships must pay more attention to and assist lower-income countries to achieve higher growth rates.

1.Introduction

Income and income growth are the most widely agreed indicators in measuring well-being. A higher income indicates that individuals have a higher purchasing power to consume goods and services, resulting in higher satisfaction and happiness. Although other dimensions might be used to capture the level of welfare, such as health, education, and other basic needs, most are closely related to income. This is because income is the source of wealth to be allocated to increase individuals' utility. This indicates that income is the central dimension in achieving a higher standard of living. Therefore, it is evident that all countries and their governments attempt to increase the income of their citizens.

At the macro level, per capita gross domestic product is the standard indicator of income level. That's why all countries attempt to increase their national income and accelerate growth. Some growth theorists believe poorer countries generally can grow faster than affluent countries, resulting in income convergence. This income convergence is a fundamental implication of neoclassical growth theories. Neoclassical growth theories imply that the income levels of poorer countries grow faster and converge with those of more affluent countries, whose income levels grow lower. The negative association between per capita income and the growth rate, illustrated as a negative sloping convergence line, results from diminishing marginal return to capital.

In contrast to neoclassical theories, new growth theories do not have income convergence as an implication, which means that the gap between poorer and richer countries might get more expansive instead of shrinking. This is proven by the fact that attempts to find global convergence often fail since it assumes that worldwide production functions, including productivity and technological progression, are perfectly identical. While unconditional or global convergence frequently does not exist, literature usually proves the occurrence of conditional convergence, which takes into account heterogeneity in geography, colonial heritage, culture, human and natural resources, and other socioeconomic aspects. Therefore, such a conditional or club convergence might exist at a different income level for different clusters of countries (Tomal, 2024).

A massive body of literature repeatedly proves the existence of club or conditional convergence, such as convergence among BRICS countries (Das et al., 2021), OECD countries (Desli & Gkoulgkoutsika, 2021; Yucel et al., 2024), Asian countries (Ito, 2017), sub-Saharan African (Jamilu et al., 2024), and Europe (Bal-Domańska, 2024; Savoia, 2024; Vale, 2024). However, studies that include all economies worldwide are limited. Some studies in income convergence analyze solely the dispersion of income per capita, such as by Ram (2018), which confirms σ-convergence without verifying β-convergence first. Some others verify the conditional β-convergence without dealing with the endogeneity problem, which might yield bias parameter. Furthermore, income convergence is the implication of economic growth driven by the supply side, which takes place in the long-run concept. Hence, instead of employing annual growth, such as Jamilu et al. (2024)and Li et al. (2016), longer period for the growth rate is needed.

Income may represent society's welfare, while the trend or growth rate may capture the improvement of society's well-being and living standards over time. Therefore, the

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investigation of economic convergence is essential (de Janvry & Sadoulet, 2016). Research in income convergence is expected to reveal whether per capita income disparities across countries will vanish or at least diminish over time. Therefore, this study aims to verify whether income convergence, both β-convergence and σ-convergence, occurs among economies. In addition to global (unconditional) convergence, this study will conduct subsample analyses to verify the occurrence of club convergence for some groups of countries, namely G20 countries, OECD countries, low-income countries, lower-middle-income countries, upper-middle-income countries, and high-income countries. It is expected that income convergence will occur across countries, if not at the global level, at least within those groups (club convergence) due to similar characteristics among countries within country groups.

This study will provide three main contributions. First, while most previous studies focused on particular types of convergence (absolute or conditional, global or club convergence, β or σ convergence), this study investigated all of those types. Second, the analysis follows a more accurate procedure, starting from β-convergence as the necessary condition and continuing to σ-convergence as the sufficient condition. The results is expected to be meningful, especially for international organizations, to pay more attention on contries experincing divergence or stagnation in income growth.

2.Literature Review

The concept of β-convergence emerges as an implication of the diminishing return of capital assumption, which implies that marginal productivity of capital declines as the capital stock per labour rises. Mathematically, one of the most important assumptions of a production function Y=F(K,L) is quasi-concave, meaning that the first partial derivation of output with respect to labour is positive, or $f_k>0$ while the second partial derivation is negative, or $f_{kk}<0$.

In terms of cross-country comparison, countries with lower incomes will grow faster than countries with higher incomes since the marginal product of capital in poorer countries is higher than in more affluent countries. If this theory is accurate, the income growth rate will be negatively correlated with the initial income, proven by the downward-sloping association line. This sparks a convenient methodology to investigate the occurrence of income convergence, namely, regressing the growth rate over time with the initial income level. β-convergence occurs when the initial per capita income impacts the growth rate negatively.

The β-convergence concept is divided into conditional and unconditional β-convergence. Assuming countries' production functions are Cobb-Douglas, or

$$Y_t = K_t^a(A_tL_t)^{1-a} \quad \ldots\ldots (1)$$

with Y representing output/income, K denoting physical capital, A referring to total factor productivity and L denoting labour; the steady-state per capita income y* can be represented as

$$y^* = A_0 e^{gt}\left[\frac{s}{n+g+\delta}\right]^{\frac{\alpha}{1-\alpha}} \quad \ldots\ldots (2)$$

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where s denotes the saving or investment rate, g represents technological progression, and n refers to the population growth rate. Unconditional convergence assumes that all countries have the exactly same production function with exactly the same characteristics, in this case, represented by the exact same value of all parameters. In the econometric regression model, this condition is represented by the impact of initial income on growth rate, which should be negatively significant without including any other explanatory variables. In short, the econometric model to investigate the existence of unconditional convergence can be expressed as

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = a - \frac{1-e^{\lambda T}}{T}\ln(y_{i0}) + \varepsilon_{it} \quad \text{(3.a)}$$

Where T denoting the length of the period, y_{iT} denoting the income at the end of each period, yi0 referring to the initial income at each period, λ being the speed of convergence, α being a constant parameter, and εit being error terms. The equation (3.a) can be transformed into a standard econometric regression model as

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = a + \beta\ln(y_{i0}) + \varepsilon_{it} \text{ where } \beta = -\frac{1-e^{\lambda T}}{T} \quad \text{(3.b)}$$

Conversely, conditional β-convergence considers heterogeneity in the steady-state income, which is represented by the variation of the production function and parameters of those functions. Consequently, the model should employ some covariates to accommodate the variation among countries. The general econometric model for investigating conditional β-convergence can be expressed as

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = a + \beta\ln(y_{i0}) + \sum \boldsymbol{\theta}\mathbf{X}_{\mathbf{it}} + \varepsilon_{it} \quad \text{(4)}$$

Where $\boldsymbol{\theta}$ is a vector of each covariate's parameter, and $\mathbf{X}$ is the matrix of control variables. Besides β-convergence, there is a concept of σ-convergence, which concerns cross-sectional income dispersion over time. If the dispersion of per capita income decreases as time goes by, then σ-convergence occurs. Suppose that σ_t^2 is the variance of per capita income at time t, then its motion over time can be expressed as

$$\sigma_t^2 = e^{-2\lambda}\sigma_{t-1}^2 + \sigma_{\varepsilon t}^2 \quad \text{(5)}$$

If the error term is homoscedastic, $\sigma_{\varepsilon t}^2$ constant for all t and can be denoted as σ_ε^2. Hence, the solution for the equation (5) is

$$\sigma_t^2 = \frac{\sigma_\varepsilon^2}{1-e^{-2\lambda}} + e^{-2\lambda t}\left(\sigma_0^2 - \frac{\sigma_\varepsilon^2}{1-e^{-2\lambda}}\right) \quad \text{(6)}$$

The steady-state value of variance in equation (5) is $\sigma^2 = \sigma_\varepsilon^2/(1-e^{-2\lambda})$ which increases in σ_ε^2 and decreases in the parameter of speed convergence λ. Additionally, σ_t^2 increases if and only if $\sigma_0^2 > \frac{\sigma_\varepsilon^2}{1-e^{-2\lambda}}$. Therefore, the positive λ, which implies β-convergence occurrence, does not ensure σ-convergence occurrence. While β-convergence is the necessary condition for income convergence existence, σ-convergence is the sufficient condition (Ghatak & De, 2019).

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3.Research Method

This study utilizes a two-way fixed effect panel model on countries as the observation unit from 1980 to 2022. The data was compiled from the World Bank through https://databank.worldbank.org/. In addition to per capita gross domestic product (GDP) measured in 2015 US$ constant price, several variables are employed as covariates, including life expectancy at birth (in years) for the total population, the total fertility rate (births per woman), the proportion of government expenditure to GDP, the ratio of gross fixed capital formation to GDP, the inflation rate, openness, the percentage of urban population, and annual population growth. The sample for this research consists of 93 countries representing G20, OECD, low-income countries, lower-middle-income countries, upper-middle-income countries, and high-income countries. It is desired to employ as many countries as possible for better estimation. However, due to data availability, the trade-off between the number of countries and the data series length cannot be avoided.

Neoclassical growth theory assumes that growth is driven through the supply side, which requires a long-run perspective (Heijdra, 2017; Scarth, 2014). Therefore, considering the trade-off between the number of segments and the length of each segment, this study divides the total period into 6 segments, which are t = 1 for 1980-1987, t = 2 for 1987-1994, and so on, with t = 6 for 2015-2022 as the last segment.

The initial GDP per capita is the value of GDP per capita at the beginning of each segment, namely GDP per capita in 1980, 1987, and so on. The logarithmic transformation of the initial GDP per capita is employed as the variable of interest, and the effect (represented by the parameter β) indicates whether income convergence exists. Logarithmic transformation is employed since it is monotonic and holds the same distribution as the original variable. This transformation is also implemented in seminal studies, such as Cabral & Castellanos-Sosa (2019), Das et al. (2021), Desli & Gkoulgkoutsika (2021), Ghatak & De (2019), Ito (2017) and Li et al. (2016).

Several control variables are included in the model to avoid or at least minimize omitted variable bias. Those covariates include life expectancy at birth (Ghatak & De, 2019; Li et al., 2016), total fertility rate and population growth (Cabral & Castellanos-Sosa, 2019; Ghatak & De, 2019), government expenditure (Ghatak & De, 2019), capital formation (Cabral & Castellanos-Sosa, 2019; Das et al., 2021; Li et al., 2016), inflation (Li et al., 2016), openness (Ghatak & De, 2019), and urban population (Ghatak & De, 2019; Li et al., 2016).

Since the initial per capita GDP is not strictly exogenous, the endogeneity problem should be handled to obtain unbiased estimators of the model. To handle the endogeneity issue, this research employs a two-way fixed effect model. The general form can be expressed as

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = \alpha_i + \gamma_t + \beta \ln(y_{i0}) + \mathbf{X_{it}\Theta} + \varepsilon_{it} \quad \text{where} \quad \alpha_i = \alpha + \mathbf{A_i'\varphi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

with $\mathbf{A_i'}$ is invariant characteristics of each country, either observed or unobserved, which are not captured in a set of control variables $\mathbf{X_{it}}$ and $\boldsymbol{\varphi}$ is a set of parameters. Through

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equation (7), the causal effect of the initial GDP per capita on its growth rate can be estimated by treating both individual effect α_i and time effect γ_t as fixed effects. As time-invariant individual attributes are absorbed in the individual fixed effect α_i and time-variant disturbance is captured in the time-fixed effect γ_t, β is an unbiased estimate of the causal effect of the initial per capita GDP on growth rate (Angrist & Pischke, 2014). Therefore, the main hypothesis to be confirmed through this research is

$$Ho : \beta \geq 0 \quad (\beta\text{-convergence does not occur})$$
$$Ho : \beta < 0 \quad (\beta\text{-convergence occurs})$$

After confirming β-convergence occurrence, this study will investigate the occurrence of σ-convergence by measuring the dispersion of per capita GDP over time. Replicating the method used by Ram (2018), the dispersion is captured by the standard deviation of the natural logarithm (SDLOG) of per capita GDP and coefficient variation (CV) of per capita GDP. SDLOG and CV are defined as

$$SDLOG_t = \left\{\frac{1}{N}\sum_{i=1}^{N}\left(\ln(y_{it}) - \frac{1}{N}\sum_{i=1}^{N}\ln(y_{it})\right)^2\right\}^{0.5} \quad \ldots\ldots (8)$$

$$CV_t = \frac{\left\{\frac{1}{N}\sum_{i=1}^{N}\left(y_{it} - \frac{1}{N}\sum_{i=1}^{N} y_{it}\right)^2\right\}^{0.5}}{\frac{1}{N}\sum_{i=1}^{N} y_{it}} \quad \ldots\ldots (9)$$

where y_{it} denotes the level of GDP per capita of country i at the time t. To verify the σ-convergence, these dispersion indicators are regressed as a function of time to check whether the dispersion decreases over time, mathematically expressed in the time series model as

$$D_t = a + b(t) + \varepsilon_t \quad \ldots\ldots (10)$$

where Dt is the dispersion indicator (SDLOG and CV) at time t. A negative trend (negative b) implies that the dispersion declines, which indicates σ-convergence, while a positive trend indicates that the income diverges as time passes.

4. Results and Discussion

The Gross Domestic Product (GDP) per capita growth rate between 1980 and 2022 varies among countries. On average, upper-middle-income countries experienced the highest growth rate, comprising about 2.48 percent per year, followed by OECD countries and high-income countries, at 2.47 percent and 2.41 percent per year, respectively. For 42 years, per capita GDP in high-income, upper-middle-income, and OECD countries have doubled or grown more than twice compared to per capita GDP in 1980. Being contrast to the classical theories, low-income countries only experienced 0.42 percent growth rate or less than 20 percent for 42 years. The comparison of the total growth rate and the average annual growth rate among countries' groups is presented in Table 1.

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Table 1. Countries' GDP per Capita Growth from 1980 to 2022

Indicators	G20	OECD	Low Income	Lower-Middle	Upper-Middle	High Income	All Countries
Samples	17	28	12	23	25	33	93
Annual growth (%)	1.93	2.47	0.42	1.59	2.48	2.41	2.37
Total growth (%)	80.99	103.57	17.82	66.96	103.97	101.35	99.60

Source: World Bank data, processed

Figure 1 illustrates the progression of GDP per capita among groups of countries between 1980 and 2022. High-income cluster has the highest per capita GDP, which is slightly higher than OECD countries. Besides the picture scale, this happens because of overlapping membership of OECD and high-income countries. Most high-income countries are also OECD members, and most OECD members have high incomes. While high-income countries, OECD countries, and G20 countries experienced significant growth, low-income and lower-middle-income countries seem stagnant and have no significant growth in their income per capita.

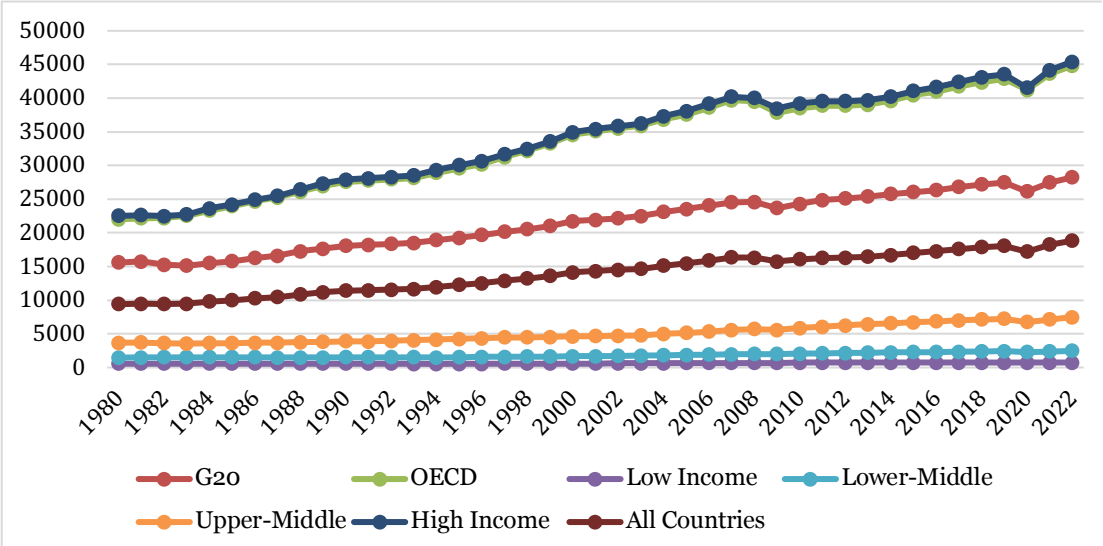

Figure 1. The trend of GDP per Capita among Countries Groups between 1980 and 2022
Source: World Bank data, processed

Following neoclassical growth theory, the GDP per capita growth rate is analyzed through the supply side, which requires long-run terms (Heijdra, 2017; Romer, 2019; Scarth, 2014). Dividing the whole period into 6 segments, we obtain long-run growth (average annual growth every 7 years). The scatter plot in Figure 2 implies that for every group of countries, the (long-run) growth seems negatively correlated to the initial GDP per capita.

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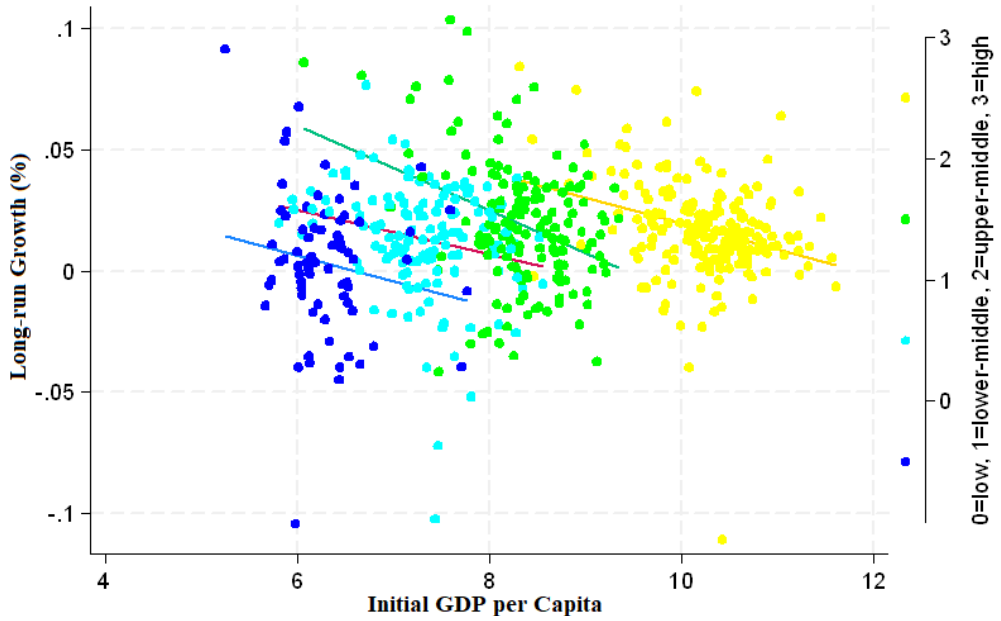

Figure 2. Scatter Plot of Growth Rate and Initial GDP per Capita
Source: World Bank data, processed

β-convergence model estimation is conducted through a fixed effect panel model. The fixed effect is chosen since countries' characteristics are most likely invariant across time and associated with countries' economic growth. These determinants include broadly agreed factors such as natural and human resources, culture, government funding and expenditure (Abdillah, 2023; Charles et al., 2023), and geographic characteristics to less popular factors, such as tourism (Wahyu et al., 2022), zakat (Bagus Wiranatakusuma, 2024; Fatah & Usman, 2024), and kangaroo market (Fatah & Usman, 2024). Most seminal studies on this subject also utilize fixed effect panel models, such as Cabral & Castellanos-Sosa (2019), Das et al. (2021), Desli & Gkoulgkoutsika (2021), Ghatak & De (2019), Ito (2017), Li et al. (2016) and Ram (2018). It is expected that the fixed effect panel approach gives a better estimate of the effect of the initial per capita GDP on growth than the ordinary least square (pooled) or random effect approach. The assumption for the OLS or random effect model, which states that there is no association between countries' attributes and per capita income growth, is too naive to be implemented.

Table 2. Unconditional β-Convergence, Fixed Effect Estimation

Variable	G20 countries	OECD countries	Low income	Lower middle	Upper middle	High income	All countries
Initial GDPpc	-0.017***	-0.020***	-0.047**	-0.009	-0.013*	-0.029***	-0.021***
	(0.00427)	(0.00363)	(0.0149)	(0.00779)	(0.00528)	(0.00372)	(0.00311)
Constant	0.182***	0.224***	0.299**	0.0845	0.128**	0.318***	0.193***
	(0.0402)	(0.0368)	(0.0942)	(0.0570)	(0.0441)	(0.0381)	(0.0265)
R^2	0.162	0.185	0.143	0.013	0.047	0.275	0.089
N	102	168	72	138	150	198	558

Source: World Bank data, processed

The model for investigating unconditional β-convergence is presented in Table 2. Long-run growth is negatively affected by the initial per capita GDP, illustrated by the negative sign of coefficient β. The parameters of interest in all sub-samples, except for lower-middle-income countries, are negatively significant. This result implies that global (unconditional) β-convergence exists for all countries and club unconditional β-convergence exists for all groups except lower-middle-income countries. However, the parameter in this model still has a potential omitted variable bias because numerous factors determine economic growth besides the initial per capita gross domestic product. Moreover, the initial per capita GDP is not strictly exogenous and most likely correlates with other characteristics. For these reasons, the speed of convergence, usually denoted as λ, will not be analyzed based on this model but through the two-way fixed effect model, which yields an unbiased estimator for parameter β.

Table 3. Conditional β-Convergence, Two Way Fixed Effect Estimation

Variable	G20 countries	OECD countries	Low income	Lower middle	Upper middle	High income	All countries
Initial per cap GDP	-0.028***	-0.043***	-0.071***	-0.044***	-0.042***	-0.057***	-0.044***
	(0.00780)	(0.00800)	(0.01820)	(0.00964)	(0.00697)	(0.00709)	(0.00412)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.247***	0.430***	0.607***	0.313***	0.229***	0.426***	0.326***
	(0.06500)	(0.08790)	(0.14700)	(0.08060)	(0.06520)	(0.09700)	(0.03870)
R^2	0.547	0.518	0.529	0.477	0.500	0.527	0.310
N	102	167	70	135	146	197	548
Implied λ	3.154%	5.087%	9.658%	5.202%	4.931%	7.257%	5.231%

Source: World Bank data, processed

A two-way fixed-effect panel model is employed to obtain unbiased estimators for the effect of the initial GDP per capita on economic growth. Moreover, several covariates are employed in the model to avoid omitted variable bias. As seen in Table 3, the initial GDP per capita coefficient, representing the initial GDP's effect on economic growth, is negative and significant for countries clubs (all sub-sample analyses). The negative impact of initial GDP per capita means that poor countries with lower GDP per capita generally have a greater growth rate. In contrast, rich countries with higher GDP per capita seem to have a lower growth rate, given that other factors are constant (ceteris paribus). This implies that global and club conditional β-convergence occurred among those countries from 1980 to 2022. This result is in line with classical growth theories and most previous research, such as among sub-Saharan Africa (Huffman & Huffman, 2021; Jamilu et al., 2024), European region (Bal-Domańska, 2024; Cabral & Castellanos-Sosa, 2019; Savoia, 2024; Vale, 2024), Asia (Ito, 2017; Yaya et al., 2020) and BRICS countries (Das et al., 2021).

Obtaining unbiased parameter β, the speed of convergence, which is denoted as λ, is measured based on the equation (3.b). The result implies that the global speed

convergence is approximately 5.231 percent. Among groups of countries, low-income countries have the fastest convergence speed, comprising approximately 9.66 percent, followed by high-income countries, at approximately 7.26 percent. The lowest convergence speed occurs within G20 countries, followed by upper-middle-income countries, comprising 3.15 percent and 4.93 percent, respectively.

After confirming β-convergence occurrence, the analysis is continued by investigating σ-convergence existence. To do so, GDP per capita dispersion among countries is analyzed yearly to determine whether it decreases over time. Following the method employed by Das et al. (2021) and Ram (2018), the dispersion of GDP per capita is measured by the standard deviation of the natural logarithm (SDLOG) of per capita GDP and the coefficient variation (CV) of per capita GDP. The SDLOG and CV fluctuation during the 43-year period is provided in Figure 3. It can be inferred that the dispersion of GDP per capita seems to decrease as time passes, except for low-income countries and all samples. However, formal econometric analyses should be conducted to conclude whether σ-convergence occurs during the period.

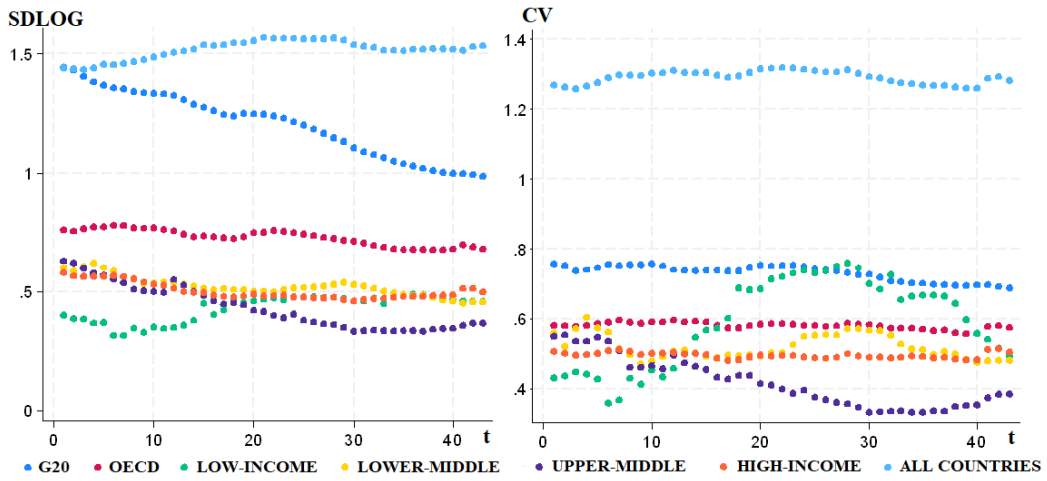

Figure 3. Dispersion of GDP per Capita among Countries between 1980 and 2022
Source: World Bank data, processed

Formal econometric analysis is conducted by regressing the dispersion of GDP per capita (SDLOG and CV) with a time period (t = 1, 2, ..., 43). The result, displayed in Table 4, implies that global σ-convergence does not occur, as indicated by the positive and significant estimator b for the SDLOG model. As time passes, the standard deviation gets wider instead of shrinking. The same circumstance also happens in low-income countries, where both SDLOG and CV are significantly increasing in time, implying that the income gap between countries is getting wider. Furthermore, σ-convergence exists in other clubs of countries besides those two. The inexistence of global σ-convergence is in line with some seminal studies, such as Ram (2018) and Pukin-Sowul & Włodarczyk (2024).

Table 4. σ-Convergence, Ordinary Least Square Estimation

Groups	Dep. Var.	t	s.e. (t)	constant	s.e.(cons)	R^2	N
G20	CV	-0.00156***	0.000149	0.765***	0.00375	0.728	43

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Groups	Dep. Var.	t	s.e. (t)	constant	s.e.(cons)	R^2	N
counties	SDLOG	-0.01100***	0.000230	1.446***	0.00569	0.983	43
OECD	CV	-0.00049***	0.000088	0.590***	0.00224	0.433	43
countries	SDLOG	-0.00247***	0.000180	0.784***	0.00450	0.824	43
Low	CV	0.00595***	0.001250	0.458***	0.03160	0.355	43
income	SDLOG	0.00353***	0.000410	0.351***	0.01050	0.639	43
Lower	CV	-0.00066	0.000421	0.534***	0.01060	0.057	43
middle	SDLOG	-0.00289***	0.000260	0.584***	0.00649	0.755	43
Upper	CV	-0.00520***	0.000363	0.530***	0.00917	0.833	43
middle	SDLOG	-0.00692***	0.000400	0.585***	0.01020	0.878	43
High	CV	-0.00024*	0.000099	0.500***	0.00252	0.121	43
income	SDLOG	-0.00205***	0.000300	0.546***	0.00750	0.539	43
All	CV	-0.00024	0.000229	1.296***	0.00579	0.025	43
countries	SDLOG	0.00192***	0.000400	1.475***	0.01010	0.360	43

Source: World Bank data, processed

The σ-convergence inexistence in low-income countries can be the consequence of several factors. Low-income countries' economies are generally sharply oscillated and vulnerable to socioeconomic, natural, and political shocks. Some low-income countries have issues with political instability, internal conflicts, and civil wars (Baysoy & Altug, 2021). Relying on natural resources, low-income countries' economies are more severely impacted by natural disturbances, such as drought, flood, and other natural disasters. Due to the lack of skilled human resources, low-income countries tend to export raw commodities, such as crops or mining products, without any manufacturing process, making their economies severely affected by price volatility. While few conducive countries experienced considerable growth, countries facing those obstacles will likely experience stagnancy in their economies for an extended period. In the worst scenario, their income falls dramatically due to the destruction of infrastructure, disruption of society and social order, natural disasters, and scarcity of resources.

Based on this finding, international organizations and developed countries should pay more attention to and assist low-income countries to achieve higher economic growth. Relying only on national resources without international partnerships, most low-income countries tend to have a lower economic growth rate, if not stagnancy. Global cooperation and assistance from high-income countries are necessary to help them escape poverty and achieve higher economic growth.

5.Conclusion

Employing fixed effect panel models, it is confirmed that both conditional and unconditional β-convergence occur among countries. Moreover, club β-convergence exists for all clusters of countries, including G20 countries, OECD countries, low-income, lower-middle-income, upper-middle-income, and high-income countries. Additionally, the analysis reveals that although global σ-convergence does not occur, it occurs among G20 countries, OECD countries, lower-middle-income, upper-middle-income, and high-

income countries. σ-convergence among low-income countries does not exist since their incomes sharply fluctuated due to vulnerability to socioeconomic, natural, and political shocks. Therefore, international partnership and global assistance are needed so that their economy grows faster and catches up with high-income countries.

Several limitations that can be improved for the next research include improving econometric models, such as dynamic models. Income (in this context, per capita GDP) is likely to experience temporal autocorrelation, meaning that current income is determined by income in previous periods. Many factors determine economic growth, and if those factors are not controlled, omitted variable bias will likely emerge in the estimation. Hence, controlling other factors might be important for future improvement.

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