Mirjana Jeleč Raguž
Josip Juraj Strossmayer
University of Osijek
Faculty of Tourism and
Rural Development in Požega
34000 Požega, Croatia
mjelecraguz@ftrr.hr

JEL: O47, O11, O57
Original scientific article
https://doi.org/10.51680/ev.39.1.3

Received: February 27, 2025
Revision received: July 31, 2025
Accepted for publishing: September 1, 2025

INCOME DISPARITIES AND CONVERGENCE ACROSS GLOBAL REGIONS

Abstract

Purpose: This paper explores global income distribution and inequality from 1990 to 2023, analyzing 183 countries across 10 regions.

Methodology: Using PPP-adjusted GDP *per capita* data for 183 countries, the study assesses income dynamics across ten world regions through β-convergence (linear regression), σ-convergence (standard deviation), and the catch-up index (relative dynamics of income).

Results: The results reveal a complex picture: while overall income disparities between countries have decreased (β-convergence), regional comparisons with the U.S. as a benchmark show diverse trends. Of the nine analyzed regions (excluding the U.S.), five exhibit convergence, while four show divergence, based on σ-convergence and the catch-up index. Eastern Europe and South Asia have made the most progress in narrowing the income gap, whereas the Middle East & North Africa and Sub-Saharan Africa have fallen further behind. Despite maintaining minimal disparities with the U.S., Western Europe and the Western Offshoots have exhibited signs of mild divergence. These results highlight the heterogeneity of income dynamics across regions.

Conclusion: This study provides a nuanced perspective on convergence dynamics, emphasizing that the process of economic catch-up is neither uniform nor guaranteed. The results highlight that regions characterized by political stability, strong institutional capacity, and sustained investment in education and technology, such as Eastern Europe, are advancing more effectively. In contrast, regions facing persistent political instability, weak institutional frameworks, and limited investment—particularly Sub-Saharan Africa and the Middle East & North Africa—continue to fall behind. These findings point to the importance of targeted policy interventions aimed at fostering inclusive and balanced global economic development.

Keywords: Global inequality, income distribution, economic convergence, economic growth, world, global regions

1. Introduction

Understanding the global distribution of income and its evolution over time remains a central question in contemporary economic research. The significance of this issue is underscored by the 2024 Nobel Prize in Economic Sciences, awarded to scholars investigating the fundamental determinants of large cross-country differences in income per capita (Acemoglu et al., 2001).

This topic has long been debated in political, professional, and academic circles. Barro and Sala-i-Martin (1991, p. 107) raised critical questions about whether the poorer countries of Africa, South Asia, and Latin America would grow faster than developed nations, whether southern Italy would catch-up with the north, and similar concerns. However, as noted by Jarco (2018), who reviewed empirical studies on the convergence hypothesis, the literature does not provide a clear consensus. The ongoing debate on economic convergence remains unresolved, reinforcing the need for further research in this area.

This paper analyzes income distribution among the 183 member countries of the World Bank (WB) and the International Bank for Reconstruction and Development (IBRD), both at a general level and across various global regions, using the U.S. as the benchmark country during the period from 1990 to 2023. Quantitative methods are employed to investigate convergence processes and developmental disparities. The focus lies on the application of β- and σ-convergence, as well as the catch-up index, allowing precise measurement of the dynamics in income disparity reduction between countries and regions.

Beta convergence estimates the rate at which lower-income countries catch up with higher income ones (commonly measured through linear regression), while σ-convergence tracks the reduction in income variability across countries/regions over time (calculated using standard deviation). The catch-up index enables comparisons of how quickly countries or regions progress in narrowing the gap with leading economies. PPP-adjusted GDP *per capita*, expressed in constant 2021 international dollars, is used as the indicator of income differences.

The necessity for this analysis stems from existing contradictions in the scientific literature. While some authors argue that global convergence is occurring (e.g., Barro & Sala-i-Martin, 1991, 1995; Milanovic, 2016), others highlight the deepening disparities between developed and less developed countries (Pritchett, 1997; Bourguignon & Morrisson, 2002). To contribute to this debate, this study utilizes purchasing power parity (PPP) adjustments data to ensure greater comparability between regions.

To achieve a deeper understanding of global and regional trends, the world is divided in this paper into ten regions based on geographic, economic, and developmental criteria, which is also the added value. In this paper, the regions were not literally adopted according to the World Bank classification; instead, they were independently formed based on the specified criteria. For example, the World Bank's region Europe and Central Asia is divided in this study into three regions: Western Europe, Eastern Europe, and Central Asia, due to their different developmental, economic, geographic, cultural, and historical criteria (partly political as well). This approach provides deeper insight into and facilitates the identification of global convergence trends among regions that are not at the same initial level of development.

This segmentation allows for the identification of region-specific characteristics and provides broader insights into developmental dynamics. Particular emphasis is placed on the role of the United States as a global economic leader and a reference point for assessing the progress of other regions (a benchmark country).

The aim of this study is to provide empirically grounded insights into global and regional trends in income distribution, offering new perspectives on the developmental challenges and potential across different parts of the world.

The paper is structured into five sections. Following the introduction, the second section explains the concept of convergence and reviews relevant academic and professional literature on global economic convergence. The third section outlines the research methodology, and presents the results based on β- and σ-convergence and the catch-up index. Section 4 discusses the findings and their policy implications. The final section presents the main conclusions of the paper, including research findings, open questions, and suggestions for further research.

2. Literature review

The analysis of world income distribution has been a central topic in economics, particularly in the context of globalization and regional disparities. This literature review synthesizes key theoretical frameworks and empirical findings, highlighting both their contributions and limitations. The concept of economic convergence is deeply embedded in growth theories, with differing perspectives on

the potential for convergence from neoclassical and endogenous growth models.

Traditional neoclassical economic theory (Solow, 1956) considers convergence between developed and less developed countries to be realistic due to diminishing returns on capital investments. However, the modern version of neoclassical growth theory (Sato, 1966) incorporates technological progress, explaining why real convergence has yet to be fully realized. In this framework, while capital investments face diminishing returns, technological advancements drive faster growth in developed countries.

In contrast to neoclassical theory, endogenous growth theory (Romer, 1986; Lucas, 1988) argues that convergence is not inevitable. It emphasizes that growth factors such as knowledge, R&D investments, human capital, and technology do not exhibit diminishing returns, enabling sustained growth predominantly in resource-rich developed countries.

A substantial body of empirical research has examined whether convergence or divergence characterizes global income trends. The findings yield mixed results on the convergence hypothesis, varying by time period, geographical focus, and methodology.

Early studies by Barro and Sala-i-Martin (1991; 1995) identified regional income convergence in U.S. states between 1880 and 1988, and slow convergence in Europe, Japan, and the U.S., estimating a 2% annual reduction in income disparities. Barro (2015) later described this as the "iron law of convergence," where income gaps close gradually, often over generations.

Pritchett (1997) provided a contrasting view, arguing that the income gap between rich and poor countries widened significantly between 1870 and 1990. Despite evidence of convergence among wealthier nations after 1960, Pritchett emphasized that global income inequality persisted.

Schultz (1998) found evidence of faster income growth among poorer nations (β-convergence) and a reduction in income inequality (σ-convergence). His findings suggest that while global income inequality increased between 1960 and 1968, it has decreased since the mid-1970s, though this decline is less evident if China is excluded.

Maddison (2001) concluded that global economic development over the last millennium (from the year 1000 to the end of the 20th century) has been highly uneven, with significant disparities between regions in terms of growth rates and living standards. Despite general progress, economic differences between regions, such as those between the United States and Africa, have become vast, and the gap between developed and developing regions continues to widen. While recent decades have seen progress in Asia, global economic growth has slowed since 1973, and stagnation in other regions has reduced overall global progress.

Bourguignon and Morrisson (2002) examined income trends over two centuries, highlighting the growing divergence between industrialized Western countries and less developed regions in Africa and South Asia. They argued that this divergence was exacerbated by colonial histories and uneven industrialization. Similarly, Cole and Neumayer (2003) found limited evidence of absolute convergence but noted conditional convergence, where poorer countries experience faster growth under certain conditions.

Sala-i-Martin (2006) analyzed eight measures of global income inequality from 1970 to 2000, finding reductions in global inequality during the 1980s and 1990s. Milanovic (2011) also noted that after two decades of income divergence, the trend reversed in 2001, with poorer countries, particularly in Africa, post-Communist countries, and Latin America, experiencing higher growth rates. Milanovic (2016) emphasized the decline in inequality between countries but the rise within countries, opening up a discussion of long-term trends. He identified the winners and losers of globalization, noting that the middle class in developing countries and the global elite benefit, while the middle class in developed countries loses out.

Despite some positive findings, other studies highlight persistent divergence. Rey and Peron (2012) found no evidence of convergence among Indian Ocean Zone countries from 1950 to 2008. Bićanić and Deskar-Škrbić (2019) point out that throughout history, there has been no strong evidence supporting absolute convergence. However, with the rise of China, India, and some African countries, alongside the slowdown of developed economies after the Great Recession, such evidence is gradually becoming more apparent.

Analyzing cross-country economic growth over the past 50 years, Johnson and Papageorgiou (2020)

conclude that developing countries, as a group, have not significantly closed the income gap with advanced economies. A review of the literature on absolute convergence supports this finding, though research on cross-individual inequality suggests a decline since 2000.

Using a catch-up index, Kant (2019) demonstrated mixed results in Sub-Saharan Africa and South Asia between 1992 and 2013. While some countries showed signs of catching up, others fell behind over longer periods. He demonstrated that 28 of the 46 countries in Sub-Saharan Africa and South Asia showed signs of catching up between 1992 and 2013, using the U.S. as the benchmark, while others fell behind. Sub-Saharan Africa shows no possibility of catching up from the earliest base period, while South Asia does, at an annual rate of 0.30%, resulting in full convergence in 865 years when the U.S. is used as the benchmark country. Darvas (2019) found that global income inequality decreased due to income convergence in China and India. Without these two countries, global interpersonal income inequality across 143 countries would have been higher in 2015 compared to 1988, indicating that half of the world has not truly become more equal.

Hong, et al. (2020) estimated global income distribution trends from 1960 to 2020. Their analysis revealed significant reductions in inequality in the 2000s, driven by China and India, while Sub-Saharan Africa's contribution to inequality increased. Similarly, Patel et al. (2021) argued that since the mid-1990s, developing countries have outpaced developed ones, challenging long-held beliefs about divergence, middle-income traps, and unstable growth in poorer nations. This era of unconditional convergence marks a historic break from centuries of divergence since the Industrial Revolution.

Chatterjee and Chatterjee (2022) present findings indicating that in the post-globalization era, countries have been converging both in absolute and conditional terms. Additionally, the declining variance suggests the presence of σ-convergence.

Van Krevel (2023) demonstrated unconditional GDP convergence but also unconditional divergence of Inclusive Wealth. His study, covering a sample of 140 countries from 1990 to 2010, suggests that the episode of income convergence may be unsustainable in the long term due to the divergence in countries' capacities to generate income.

Martinho (2023) provides evidence that the indicators of convergence vary across different income levels and regions, as classified by the World Bank methodology, emphasizing the concept of convergence clubs. While the COVID-19 pandemic disrupted global convergence trends, its impact appears to have been less severe compared to the global financial crisis.

Some studies focusing on future projections indicate a slower pace of convergence in the 21st century compared to the convergence rate during the 20th century (Burgess et al., 2023). Silva Lopes (2024) notes that while some countries, led by China and India, have been catching up with rich countries at an unprecedented speed, this process seemed to lose momentum about ten years ago, and for many countries, convergence appears to have become elusive once again. In his forecasting model, based on a sample of 86 countries over a 42-year and 82-year horizon, he concludes that a large majority of these countries will still be lagging by 2060, with living standards significantly below that of U.S. citizens. In the 82-year projection until 2100, this gap is expected to persist for many nations.

Through an analysis of labor productivity convergence from 1970 to 2019, Lähdemäki (2024) finds evidence of convergence in the OECD, the EU, APEC, Europe, and Asia, while the trend remains uncertain in Africa and South America. Global β-convergence was observed throughout the period, with σ-convergence emerging after 2000.

The literature offers diverse perspectives on income convergence, ranging from optimistic views grounded in neoclassical theory to more skeptical interpretations informed by endogenous growth models. Empirical evidence remains inconclusive, reflecting the sensitivity of convergence dynamics to regional and temporal contexts, as well as methodological approaches. This study contributes to the ongoing debate by examining income convergence across all World Bank member countries grouped into ten global regions. By adopting a comprehensive approach, it aims to provide new insights into a deeper understanding of global patterns of economic convergence.

3. Methodology and research results

A review of the existing literature reveals controversial findings in the research on world income distribution across regions and time. The aim of

this paper is to contribute further to the discussion by using β- and σ-convergence methods, as well as the catch-up index. Beta convergence measures the speed at which low-income countries grow faster than high-income countries, which is examined through regression analyses comparing initial income levels with subsequent growth rates. Sigma convergence analyzes income variability among countries/regions over time. A reduction in income dispersion (measured by standard deviation) indicates the presence of σ-convergence. The catch-up index provides a direct comparison of the pace at which countries are narrowing the gap with leading nations, highlighting the relative income level of each region in comparison to the U.S.

Most research on convergence processes uses β- and σ-convergence. This paper employs both β- and σ-convergence, as well as the catch-up index. Additionally, the paper discusses the limitations of β-convergence. Specifically, β-convergence can reflect a situation where wealthier countries converge toward even wealthier ones, while poorer countries stagnate or diverge further. In this context, the catch-up index offers a more useful tool for analyzing the relative convergence of poorer countries/regions toward wealthier ones.

For the purposes of this study, the world is divided into ten regions based on geographic, economic, and developmental criteria. The grouping is partly based on models used by international organizations such as the World Bank but adapted to the specific needs of this research (the list of regions and corresponding countries can be found in Appendix A). The regions are as follows:

- Central Asia (countries of the former Soviet Union in Central Asia)
- East Asia and Pacific (excluding Australia and New Zealand, as they do not fit this group economically and developmentally)
- Eastern Europe (countries of Central and Eastern Europe, former communist and socialist countries)
- Latin America and the Caribbean (countries of Central and South America, including the Caribbean Islands)
- Middle East and North Africa (Arab world countries, Iran, and Turkey; due to cultural, historical, and political ties with the Middle East, Turkey is often included in this region, despite geographically belonging to Southeastern Europe and Western Asia)
- South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka)
- Sub-Saharan Africa (Africa south of the Sahara Desert)
- Western Europe (Western European countries that established a capitalist economic system after World War II)
- Western Offshoots (USA, Canada, Australia, and New Zealand, with the United States excluded as the benchmark country)
- United States (defined as the reference point for analysis)

The regions were not literally adopted according to the World Bank classification; instead, they were independently formed based on the specified criteria. For example, the World Bank's region Europe and Central Asia is divided in this study into three regions: Western Europe, Eastern Europe, and Central Asia, due to their different developmental, economic, geographic, cultural, and historical criteria (partly political as well). According to data from the World Bank (WB) and the International Bank for Reconstruction and Development (IBRD), 189 countries are members of the WB. Due to missing data, 183 countries are considered in this research and are subsequently grouped into ten world regions based on previously defined criteria.

The analysis is based on PPP-adjusted GDP *per capita*, expressed in constant 2021 international dollars, covering the period from 1990 to 2023. Using World Bank data, average PPP-adjusted GDP *per capita* and average annual growth rates were calculated for defined regions, forming the basis for further statistical analysis.

Beta convergence is assessed through linear regression, while σ-convergence is calculated using standard deviation, and the catch-up index provides additional insights into the relative dynamics of income across regions. Particular attention is given to the selection of the benchmark country, with the United States chosen due to its sustained economic growth and historical role as a global standard for wealth and prosperity.

The European Union was not chosen as the benchmark country due to its continuous expansion since

1973. The accession of less developed countries from Central and Eastern Europe has significantly lowered the average income *per capita*, which could lead to erroneous conclusions about the narrowing gap between poorer countries and the EU. Similarly, the OECD, which was founded in 1961 with 20 member countries, has expanded to 38 members, including countries with lower levels of development than the founding members. These changes in the composition of the EU and the OECD make them unreliable for global convergence analysis.

3.1 Results of β-convergence analysis

The concept of β-convergence describes the process by which countries or regions with lower initial income levels grow faster than those with higher income levels, thereby reducing income disparities over time. The income indicator used is GDP *per capita* at purchasing power parity (PPP), expressed in constant 2021 international dollars. The paper first presents the results of β-convergence for 183 World Bank member countries, followed by results for the defined world regions.

The statistical formula for calculating β-convergence between countries/regions in the standard regression form is given as:

$$g_i = a + \beta \cdot \ln(y_{i,0}) + \varepsilon_i \quad (1)$$

where

- $g_i = \frac{1}{T}\ln(\frac{y_{i,T}}{y_{i,0}})$ is the average annual growth rate of real GDP *per capita* in the country/region over the period from 0 to T (number of years, 33),
- $ln(y_{i,0})$ is a natural logarithm of the initial GDP *per capita* at PPP in country/region,
- α is a constant,
- β is the beta convergence coefficient we aim to estimate, obtained from the linear regression model,
- and ε_i is the random error term.

If β < 0, it indicates the presence of convergence, meaning that countries or regions with lower initial income levels tend to grow faster than those with higher income, thereby reducing income disparities over time.

Conversely, if β > 0, it indicates a lack of convergence, suggesting that countries with lower initial income levels are not catching up with wealthier ones, leading to persistent or even increasing income disparities.

Table 1 presents the results of the linear regression analysis for β-convergence among 183 member countries of the International Bank for Reconstruction and Development (IBRD) and the World Bank (WB).

Table 1 Regression results for β-convergence among 183 countries (1990-2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)

	β	R^2	F(1, 183)
PPP-based GDP per capita	-.003**	.059	16.22**

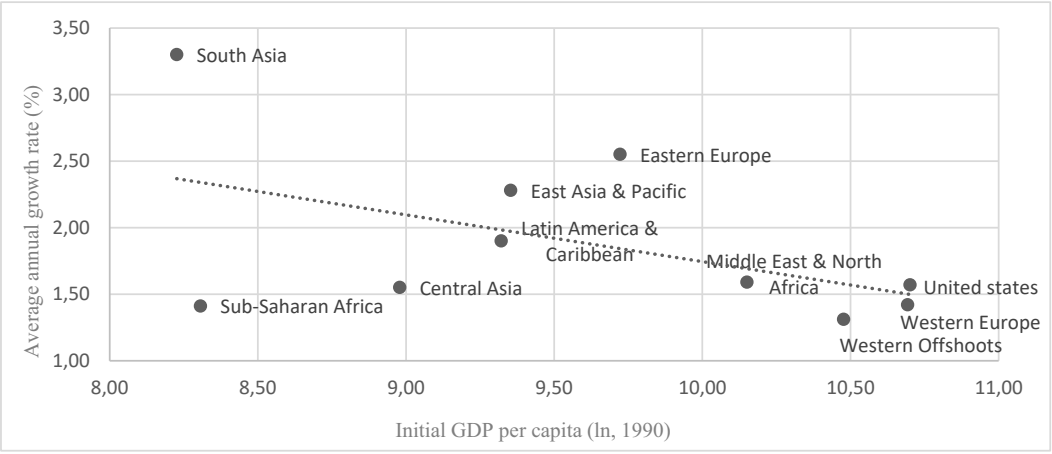
** p < .05

Source: Author's calculation based on World Bank data

The analysis of β-convergence indicates that convergence occurs when the β coefficient is negative and statistically significant (p < 0.05). The estimated β coefficient of -0.003 is statistically significant and suggests that each unit increase in the logarithmic value of initial GDP *per capita* (PPP-adjusted) corresponds to a decrease in the growth rate by 0.003 units. However, the low coefficient of determination (R^2 = 0.059) in the linear regression model indicates that only 5.9% of the variation in average annual GDP *per capita* growth rates can be explained by the initial GDP *per capita* level of the countries. In other words, the initial income level has very weak predictive power in explaining differences in GDP *per capita* growth rates across countries. This finding highlights the need for further research into other factors that contribute to economic growth.

Figure 1 and Table 2 show the results of *β-convergence* for a sample of 10 selected world regions.

Figure 1 Beta convergence across world regions (1990-2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)



Source: Author's calculation based on World Bank data

Figure 1 shows that regions with lower initial income levels (positioned on the left side of the x-axis) generally experienced higher growth rates (higher on the y-axis), whereas wealthier regions (on the right) tended to grow more slowly. The negative slope of the trend line visually confirms the presence of β-convergence, although the relationship is not statistically significant. The dispersion of data points around the regression line indicates notable deviations, some low-income regions did not grow rapidly, and conversely, certain high-income regions achieved relatively strong growth.

Table 2 Regression results for β-convergence among ten world regions (1990-2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)

	β	R^2	F(1, 8)
PPP-based GDP per capita	-.380	.259	2.870

p > .05
Source: Author's calculation based on World Bank data

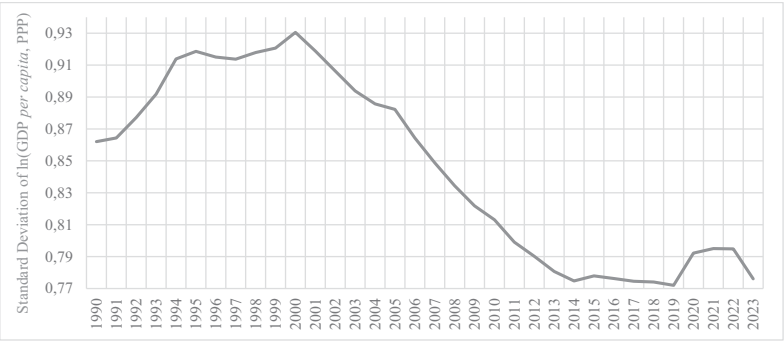
Despite the negative β coefficient, which suggests convergence (i.e., lower-income regions tend to grow faster), the results are neither strong nor statistically significant enough to confidently confirm the presence of β-convergence among the analyzed regions.

The regression results indicate statistically significant evidence of overall convergence among IBRD and WB member countries (Table 1), but only weak and statistically insignificant convergence among defined world regions (Figure 1 and Table 2). However, this does not necessarily indicate a meaningful reduction in the development gap between high-income and low-income countries or regions. It is possible that convergence is occurring primarily among wealthier countries, while poorer regions continue to lag behind. This issue will be further investigated by applying σ-convergence and the catch-up index.

3.2 Results of σ-convergence analysis

Sigma convergence examines income variability among countries or groups of countries over time. If income dispersion, measured by standard deviation, decreases, it indicates convergence among the observed groups of countries. In this analysis, income is represented by the natural logarithm of PPP-based GDP *per capita*, expressed in constant 2021 international dollars. Figure 2 illustrates the **overall σ-convergence among ten world regions** (including the United States) during the period 1990–2023, based on the standard deviation of the natural logarithm of PPP-adjusted GDP *per capita*.

Figure 2 Sigma convergence among selected world regions (1990–2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)



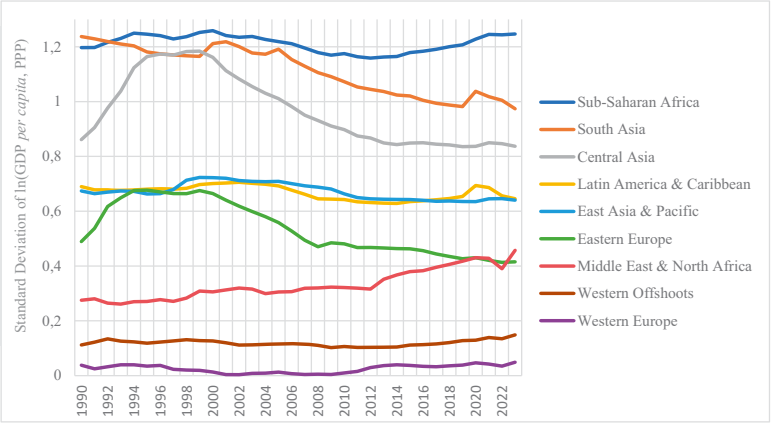
Source: Author's calculation based on World Bank data

Figure 2 illustrates the evolution of σ-convergence among ten world regions over the period 1990–2023. During the 1990s, the data reveal a pattern of divergence, as income dispersion increased across regions. However, from the early 2000s onward, a clear trend of convergence emerged, marked by a gradual decline in the standard deviation, indicating a reduction in relative income differences. This process of convergence persisted consistently until 2019. In the final years of the observed period (2020–2023), the trend appears to stagnate or even slightly reverse, likely influenced by global shocks such as the COVID-19 pandemic and heightened geopolitical instability.

Overall, the results indicate a moderate but notable degree of σ-convergence. Between 1990 and 2023, the standard deviation decreased by nearly 10%, suggesting that relative income disparities across the ten world regions have modestly diminished. While the convergence was not particularly strong, the sustained decline in income dispersion reflects a gradual narrowing of differences in GDP *per capita* levels over the long term.

Having established a moderate overall σ-convergence among the defined world regions, the analysis now turns to examining **bilateral convergence relative to the United States**. This step aims to determine whether all regions have exhibited convergence toward the U.S. benchmark, or whether the overall pattern has been driven only by some regions. The results of this analysis are presented in Figure 3 and Table 3.

Figure 3 Sigma convergence of the world regions relative to the United States (1990–2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)



Source: Author's calculation based on World Bank data

Figure 3 displays the results of bilateral σ-convergence analysis between each world region and the United States, which serves as the benchmark country. Downward-sloping trends indicate convergence, i.e., a reduction in income dispersion relative to the U.S.

The analysis shows that five of the nine regions experienced σ-convergence during the observed period (1990–2023). South Asia stands out as the strongest performer, reducing income dispersion relative to the United States by 21.77% (Table 3). Eastern Europe follows, with a reduction of 14.29% (Table 3), despite temporary divergence episodes in the 1990s. If the year 2000 is taken as the starting point for Eastern Europe, the degree of convergence becomes even more pronounced, reaching 37.51%. These two regions demonstrated the most substantial convergence toward U.S. income levels. Additional regions displaying moderate to weak convergence include Latin America and the Caribbean (-5.8%), East Asia & Pacific (-4.48%), and Central Asia (-2.33%) (Table 3).

By contrast, four of the nine regions diverged from the United States over the period. Notably, Sub-Saharan Africa currently exhibits the largest income gap relative to the U.S., despite not holding this position in 1990. At the start of the period, South Asia had the widest gap, but experienced the strongest convergence over time, while Sub-Saharan Africa diverged by 4.17% (Table 3). The region most affected by divergence was the Middle East and North Africa, where income dispersion increased by a substantial 64.29% (Table 3), indicating a strong trend of divergence relative to the U.S.

Finally, the analysis reveals that income disparities between the U.S. and other high-income regions, such as Western Europe and the Western Offshoots, remained relatively small and stable, although with slight indications of divergence.

Table 3 Summary of σ-convergence (standard deviation (SD) of ln GDP per capita) by region (1990–2023) (based on the natural logarithm of PPP-adjusted GDP per capita, in constant 2021 international dollars)

Region	SD1990	SD2023	Absolute Change	Percentage Change
South Asia	1.24	0.97	-0.27	-21.77
Eastern Europe	0.49	0.42	-0.07	-14.29
Latin America & Caribbean	0.69	0.65	-0.04	-5.8
East Asia & Pacific	0.67	0.64	-0.03	-4.48
Central Asia	0.86	0.84	-0.02	-2.33
Sub-Saharan Africa	1.20	1.25	0.05	4.17
Western Europe	0.04	0.05	0.01	25
Western Offshoots	0.11	0.15	0.04	36.36
Middle East & North Africa	0.28	0.46	0.18	64.29

Source: Author's calculation based on World Bank data

Table 3 confirms the observed σ-convergence patterns, with South Asia and Eastern Europe showing the most progress toward the U.S. benchmark, while regions such as Sub-Saharan Africa and the Middle East and North Africa diverged. These results highlight the heterogeneity of income dynamics across regions. In the next section, this analysis is complemented by examining the catch-up index, which offers additional insight into the speed and depth of convergence relative to the U.S. benchmark.

3.3 Catch-up index

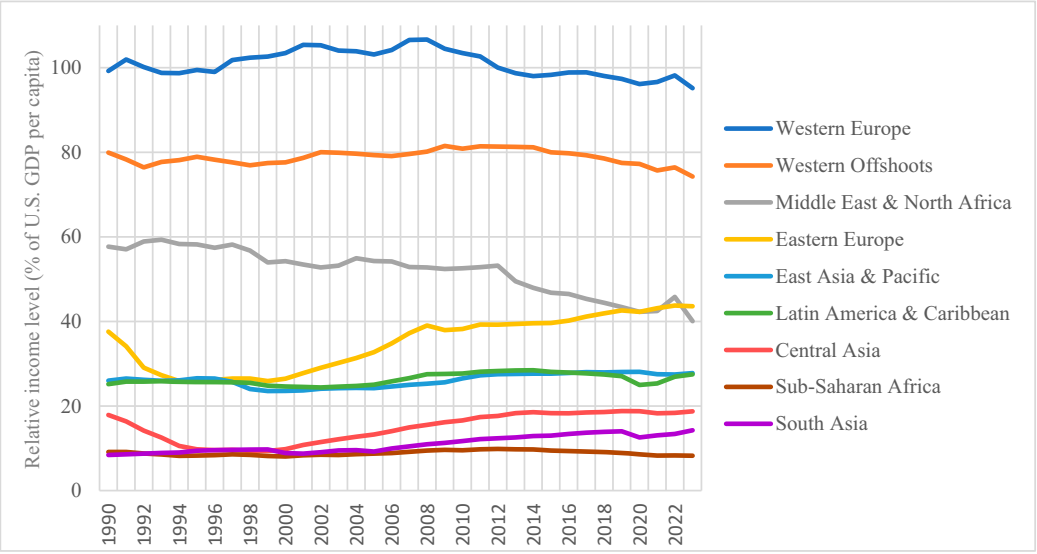
To further assess income convergence among the analyzed world regions, a catch-up index was calculated. The United States serves as the benchmark country, and the indicator used is PPPadjusted GDP *per capita*, expressed in constant 2021 international dollars. The catch-up index captures the extent to which countries or regions are narrowing the income gap with the benchmark economy over time. It is calculated as the ratio of a region's GDP

per capita to that of the United States in a given year, expressed as a percentage:

$$Catch-up\ index_t = \left(\frac{PPP-adjusted\ GDP\ per\ capita\ (regions)_t}{PPP-adjusted\ GDP\ per\ capita\ (U.S.)_t}\right) \cdot 100. \quad (2)$$

A value below 100 indicates that the country or region is lagging behind the United States, while a value above 100 suggests a higher income level. An upward trend in the catch-up index over time signals convergence, whereas a downward trend indicates divergence. The results of the analysis are presented in Figure 4.

Figure 4 Relative income level compared to the United States (1990–2023) (based on PPP-adjusted GDP per capita, in constant 2021 international dollars)



Source: Author's calculation based on World Bank data

The analysis of the catch-up index provides valuable insights into the relative income dynamics of world regions compared to the United States, which serves as the benchmark country. The index expresses each region's GDP *per capita* as a percentage of the U.S. level, thus indicating the extent of convergence or divergence over time.

Between 1990 and 2023, five of the nine regions exhibited convergence in relative income levels. Eastern Europe recorded the most significant relative improvement, increasing its catchup index from 37.59% to 43.59%, marking a 6% gain (Table 4), making it the strongest performer in terms of convergence. South Asia also showed considerable progress, with a 5.84% increase (Table 4) of the U.S. income level. Other regions, such as Latin America & the Caribbean, East Asia & Pacific, and Central Asia, experienced modest convergence, each improving their relative positions by 0.87–2.31% (Table 4). While the gains were limited, they nonetheless indicate gradual alignment toward higher income levels.

In contrast, four of the nine regions exhibited relative stagnation or divergence. For instance, Sub-Saharan Africa and Middle East & North Africa either maintained a low relative position or experienced a decline, indicating persistent structural gaps. High-income regions such as Western Europe and the Western Offshoots remained close to the U.S. income level throughout the period, although they exhibited a slight divergence over time.

Table 4 Summary of the catch-up index by region (1990–2023) (based on PPP-adjusted GDP per capita, in constant 2021 international dollars)

Region	Catch-up index (1990)	Catch-up index (2023)	Change (1990-2023)
Eastern Europe	37.59	43.59	6.00
South Asia	8.42	14.26	5.84
Latin America & Caribbean	25.17	27.49	2.31
East Asia & Pacific	25.99	27.78	1.79
Central Asia	17.87	18.74	0.87
Sub-Saharan Africa	9.12	8.26	-0.86
Western Europe	99.21	95.16	-4.06
Western Offshoots	79.94	74.26	-5.68
Middle East & North Africa	57.69	40.07	-17.62

Source: Author's calculation based on World Bank data

Overall, the findings portray a nuanced picture of global income convergence; while a few regions have made meaningful progress in narrowing the gap with the U.S., others continue to face structural barriers that hinder such advancement. The analysis therefore provides only partial support for the convergence hypothesis, revealing that income alignment is progressing in some areas but remains absent in others. This uneven pattern underscores the limited reach of convergence and the enduring structural inequalities that characterize the global economic landscape.

4. Discussion and implications

The empirical findings of this study provide nuanced evidence regarding the global convergence hypothesis. While the β-convergence analysis confirms that, on average, lower income countries have grown faster than wealthier ones over the 1990–2023 period, the weak explanatory power of the model suggests that initial income levels alone are insufficient to explain growth dynamics. This calls for a broader examination of additional structural factors influencing economic performance.

The σ-convergence analysis further highlights the complex nature of convergence dynamics. While five of the nine regions reduced their income dispersion relative to the United States, most notably South Asia and Eastern Europe, the remaining four regions, including the Middle East & North Africa and Sub-Saharan Africa, exhibited divergence. This underscores persistent income disparities and uneven development trajectories across global regions.

Results from the catch-up index corroborate these patterns, indicating relative improvement in the same five regions identified through the σ-convergence analysis, particularly Eastern Europe and South Asia, while the remaining four regions—most notably the Middle East & North Africa and Sub-Saharan Africa—regressed in their income position relative to the U.S. High-income regions, such as Western Europe and the Western Offshoots, remained closely aligned with U.S. income levels throughout the period, yet exhibited mild signs of divergence, suggesting a potential plateau in their relative economic performance.

Taken together, the results suggest that global income convergence is not a uniform process but one marked by considerable regional heterogeneity. Convergence appears more feasible where countries or regions have implemented institutional reforms, invested in education and infrastructure, and maintained political stability. Eastern Europe and South Asia exemplify such trajectories, likely benefiting from democratization, global market integration, and in the case of Eastern Europe, EU accession processes.

Conversely, regions facing persistent structural and political challenges, such as Sub-Saharan Africa and the Middle East & North Africa, continue to lag behind. This underscores the pivotal role of institutional quality, governance, and human capital

investment in shaping long-term economic development.

These findings align with the broader literature emphasizing the role of inclusive institutions and rule-based systems in promoting economic prosperity (Acemoglu et al., 2001). The 2024 laureates (Acemoglu, Johnson, and Robinson) demonstrated that inclusive institutions—those that uphold property rights, the rule of law, democratic governance, and political participation—are associated with stronger economic performance. In contrast, extractive institutions, characterized by elite-controlled wealth and power, limited citizen rights, and a lack of transparency, tend to correlate with higher corruption, inequality, and economic stagnation.

In this context, Eastern Europe—the region that has exhibited the highest convergence—provides a compelling case. Its economic progress can be attributed to institutional strengthening, democratic reforms, and legal framework improvements, driven in part by its transition from socialism and, more significantly, by structural reforms undertaken to meet EU accession criteria. Similarly, South Asia, which also demonstrated strong convergence, has seen rapid economic transformation, partly due to increasing integration into global markets and institutional reforms.

Conversely, the Middle East and North Africa—the region with the most pronounced divergence—faces persistent political instability and institutional weaknesses, factors that likely hinder economic convergence. This finding underscores the critical role of political stability and institutional quality in shaping long-term economic trajectories (Trpeski et al., 2024). The assumptions outlined in this section regarding the importance of institutional quality for longterm economic growth are intended to be examined in subsequent research.

Despite its insights, this study has several methodological limitations. First, the relatively short research period (33 years) may not fully capture long-term convergence trends. Additionally, the exclusion of certain countries due to data unavailability or classification constraints limited the sample to 183 of the 189 WB and IBRD member countries. Another methodological consideration is the choice of a single development indicator, namely PPP-based GDP p*er capita*, which does not account for broader socio-economic factors influencing convergence. Future research will seek to incorporate additional determinants of economic growth, particularly indicators of institutional quality, in order to investigate which factors contribute most significantly to long-term economic performance.

To accelerate global convergence, targeted investments in persistently lagging regions, particularly Sub-Saharan Africa, are crucial. Key policy recommendations include strengthening institutional frameworks by promoting good governance, anti-corruption measures, and legal reforms; increasing infrastructure investments, particularly in energy, transport, and digital connectivity, to enhance economic productivity; and ensuring access to quality education and technology. By addressing these challenges, policymakers can facilitate inclusive and sustainable economic growth, fostering stronger convergence trends at the global level.

5. Conclusion

This paper analyzed global income convergence across 183 countries grouped into ten regions from 1990 to 2023, using β-convergence, σ-convergence, and the catch-up index. The findings offer a nuanced view of convergence dynamics. On a global scale, β-convergence is present, as lower-income countries have generally experienced higher growth rates than their wealthier counterparts. However, this convergence is only partial and statistically modest, particularly when viewed through the lens of σ-convergence and the catch-up index. Regionally, only five of the nine regions demonstrated convergence toward the United States benchmark, particularly Eastern Europe and South Asia, while the remaining four regions, including the Middle East & North Africa and Sub-Saharan Africa, exhibited divergence. These results indicate that the process of catching up is neither uniform nor inevitable.

The main scientific claim emerging from this study is that global convergence exists, but it is conditional and highly context-dependent. While β-convergence confirms that some countries are growing faster than others, this alone is not sufficient to close the income gap. β-convergence among countries was statistically significant but explained only 6% of the variation in average annual GDP *per capita* (PPP-adjusted) growth rates by the initial GDP *per capita* level, indicating that initial income levels account for only a small portion of growth differences. In contrast, β-convergence

among world regions was not statistically significant.

General σ-convergence among regions was present but modest (the standard deviation decreased by nearly 10%), with only a limited reduction in income dispersion over the observed period. Bilateral σ-convergence, measured relative to the United States, revealed that five of the nine regions converged, while the remaining four did not. Similar patterns were observed in the results of the catch-up index. Both σ-convergence and the catch-up index suggest that real economic alignment is occurring only in regions with specific enabling conditions, such as strong institutional frameworks, political stability, and integration into global markets. Conversely, regions characterized by institutional fragility or persistent structural barriers are continuing to fall behind. These findings challenge the idea of universal convergence and underscore the significance of regional heterogeneity and developmental trajectories in shaping long-term economic outcomes.

The results also raise important questions for further research. If the initial income level has very weak predictive power in explaining differences in GDP *per capita* growth rates across countries or regions, then what factors do? To what extent do institutional quality, education systems, demographic trends, technological advancement and innovation, or international openness influence the convergence process? These findings highlight the need for further research into the broader determinants of economic growth.

Funding: This research was funded by the author's home institution through an internal competitive research project entitled "*Sustainability as a Development Paradigm: Croatia between Green Growth, Institutions, and Tourism*," implemented at the Faculty of Tourism and Rural Development in Požega, Josip Juraj Strossmayer University of Osijek, Croatia. No external funding number is associated with this project.

References

1. Acemoglu, D., Johnson, S. & Robinson, J. A. (2001). The Colonial Origins of Comparative Development: An Empirical Investigation. *American Economic Review*, *91*(5), 1369–1401. https://doi.org/10.1257/aer.91.5.1369
2. Barro, R. J. (2015). Convergence and modernization. *The Economic Journal*, *125*(585), 911–942. https://doi.org/10.1111/ecoj.12247
3. Barro, R. J. & Sala-i-Martin, X. (1991). Convergence across States and Regions. *Brookings Papers on Economic Activity*, *22*(1), 107–182. https://doi.org/10.2307/2534639
4. Barro R. J. & Sala-i-Martin, X. (1995). *Technological Diffusion, Convergence, and Growth* (NBER Working Paper No. 5151). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w5151
5. Bićanić, I. & Deskar-Škrbić, M. (2019). *Ekonomska konvergencija (I dio).* Arhivanalitika. https://arhivanalitika.hr/blog/b2b2-7-ekonomska-konvergencija-i-dio
6. Bourguignon, F. & Morrisson, C. (2002). Inequality Among World Citizens: 1820–1992. *American Economic Review*, *92*(4), 727-744. https://doi.org/10.1257/00028280260344443
7. Burgess, M. G., Langendorf, R. E., Moyer, J. D., Dancer, A., Hughes, B. B. & Tilman, D. (2023). Multidecadal dynamics project slow 21st-century economic growth and income convergence. *Communications Earth & Environment*, *4*, 220. https://doi.org/10.1038/s43247-023-00874-7
8. Chatterjee, N. & Chatterjee, T. (2022). A Comparison of Convergence among Developed and Developing Economies in a Globalized World. In Das, R. C. (Ed.), *Globalization, Income Distribution and Sustainable Development* (pp. 57–65). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80117-870-920221009
9. Cole, M. A. & Neumayer, E. (2003). The pitfalls of convergence analysis: is the income gap really widening?. *Applied Economics Letters*, *10*(6), 355–357. https://doi.org/10.1080/1350485032000072361

10. Darvas, Z. (2019). Global interpersonal income inequality decline: The role of China and India. *World Development*, *121*(2019), 16–32. https://doi.org/10.1016/j.worlddev.2019.04.011

11. Hong, S., Han, H. & Kim, C. S. (2020). World Distribution of Income for 1970-2010: dramatic reduction in world income inequality during the 2000s. *Empirical Economics*, *59*(2), 765–798. https://doi.org/10.1007/s00181-019-01657-w

12. Jarco, D. (2018). Testing and measurement of economic convergence: A review of some recent developments. *International Entrepreneurship Review*, *4*(2), 9–29. https://doi.org/10.15678/PM.2018.0402.01

13. Johnson, P. & Papageorgiou, C. (2020). What Remains of Cross-Country Convergence?. *Journal of Economic Literature*, *58*(1), 129–175. https://doi.org/10.1257/jel.20181207

14. Kant, C. (2019). Income convergence and the catch-up index. *The North American Journal of Economics and Finance*, *48*, 613–627. https://doi.org/10.1016/j.najef.2018.07.017

15. Lähdemäki, S. (2024). Cross-country convergence: to be or not to be, that is the question. *Empirical Economics*, 67(2), 839–875. https://doi.org/10.1007/s00181-024-02561-8

16. Lucas, R. E. (1988). On the mechanism of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7

17. Maddison, A. (2001). *The World Economy: A Millennial Perspective*. OECD Publishing. https://doi.org/10.1787/9789264189980-en

18. Martinho, V. J. P. D. (2023). Evidence of Global Convergence: Perspectives for Economic and Territory Planning in Times of the COVID-19 Pandemic. *Land*, *12*(6), 1251. https://doi.org/10.3390/land12061251

19. Milanovic, B. (2011). A short history of global inequality: The past two centuries. *Explorations in Economic History*, *48*(4), 494–506. https://doi.org/10.1016/j.eeh.2011.05.001

20. Milanovic, B. (2016). *Global Inequality: A New Approach for the Age of Globalization*. Harvard University Press, Belknap Press. https://doi.org/10.2307/j.ctvjghwk4

21. Patel, D., Sandefur, J. & Subramanian, A. (2021). The new era of unconditional convergence. *Journal of Development Economics*, *152*, 102687. https://doi.org/10.1016/j.jdeveco.2021.102687

22. Pritchett, L. (1997). Divergence, Big Time. *Journal of Economic Perspectives*, *11*(3), 3–17. https://doi.org/10.1257/jep.11.3.3

23. Rey, S. & Peron, O. (2012). Trade and Convergence of Per Capita Income in the Indian Ocean Zone, 1950-2008. *Annals of Regional Science*, *49*(3), 657–683. https://doi.org/10.1007/s00168-011-0462-4

24. Romer, P. M. (1986). Increasing returns and long run growth. *The Journal of Political Economy*, *94*(5), 1002–1037. https://doi.org/10.1086/261420

25. Sala-i-Martin, X. (2006). The World Distribution of Income: Falling Poverty and … Convergence, Period. *The Quarterly Journal of Economics*, *121*(2), 351–397. https://doi.org/10.1162/qjec.2006.121.2.351

26. Sato, K. (1966). On the Adjustment Time in Neo-classical Growth Models. *The Review of Economic Studies*, *33*(3), 263–268. https://doi.org/10.2307/2974420

27. Schultz, T. P. (1998). Inequality and the distribution of personal income in the world: How it is changing and why. *Journal of Population Economics*, *11*(3), 307–344. https://doi.org/10.1007/s001480050072

28. Silva Lopes, A. (2024). *Assessing Income Convergence with a Long-Run Forecasting Approach: Some New Results* (MPRA Paper No. 120143). Munich: University Library of Munich. https://doi.org/10.1111/roiw.12702

29. Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, *70*(1), 65–94. https://doi.org/10.2307/1884513

30. Trpeski, P., Tashevska, B. & Merdzan, G. (2024). The role of institutions in economic growth: A systematic literature review. *Ekonomski vjesnik: Review of Contemporary Entrepreneurship, Business, and Economic Issues*, *37*(2), 421–437. https://doi.org/10.51680/ev.37.2.14

31. Van Krevel, C. (2023). Why Cross-Country Convergence of Income is Unsustainable: Evidence from Inclusive Wealth in 140 Countries. *Social Indicators Research: An International and Interdisciplinary Journal for Quality-of-Life Measurement*, *170*, 847–875. https://doi.org/10.1007/s11205-023-03218-2

Appendix A. List of Regions and Countries

Central Asia *(4 of a total of 5)*

- **Countries**: Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan.
- **Note**: The region includes countries of the former Soviet Union in Central Asia. Turkmenistan is excluded from the sample due to data unavailability.

East Asia *and* ***Pacific*** **(27 of a total of 29)**

- **Countries**: Brunei Darussalam, Cambodia, China, Fiji, Indonesia, Japan, Kiribati, Korea Rep., Lao PDR, Malaysia, Marshall Islands, Micronesia Fed. Sts., Mongolia, Myanmar, Nauru, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, Viet Nam.
- **Note**: Australia and New Zealand, as developed countries, are excluded from the sample and included in the Western Offshoots region.

Eastern Europe *(23 of a total of 27)*

- **Countries**: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Estonia, Georgia, Hungary, Latvia, Lithuania, Montenegro, North Macedonia, Poland, Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Ukraine.
- **Note**: The region includes former communist and socialist countries. Greece, Cyprus, and Malta are excluded due to their different historical context and are instead grouped under Western Europe based on economic and developmental criteria. Kosovo is not included due to data unavailability.

Latin America *and the* ***Caribbean*** *(31 of a total of 32)*

- **Countries**: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay.
- **Note**: Venezuela RB is excluded due to data unavailability.

Middle East *and* ***North Africa*** *(19 of a total of 20)*

- **Countries**: Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, Turkey, United Arab Emirates.
- **Note**: Yemen Rep. is excluded due to data unavailability. Turkey is included due to its cultural, historical, and political ties to the Middle East, despite its geographical location in Southeastern Europe and Western Asia.

South Asia *(8)*

- **Countries**: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

Sub-Saharan Africa *(46 of a total of 48)*

- **Countries**: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Dem. Rep., Congo Rep., Cote d'Ivoire, Equatorial Guinea, Eswatini, Ethiopia, Gabon, Gambia The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.
- **Note**: Eritrea and South Sudan are excluded due to data unavailability.

Western Europe *(21)*

- **Countries:** Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece,

Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Malta, Portugal, San Marino, Spain, Sweden, Switzerland, United Kingdom.

***Western Offshoots** (4)*

- **Countries**: U.S., Canada, Australia, New Zealand.
- **Note**: The U.S. is the benchmark country, while the other three are included in the sample.