Trend Analysis of Human Development Index (HDI) Convergence in 40 Countries during 1980 to 2020

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Abstract:

This paper aims to analyze the trend of the Human Development Index (HDI) for 40 countries from 1980 to 2020 and investigate whether there's any convergence among them over the study period. For this purpose, we designed the study using a methodology that involves calculating HDI using descriptive statistics, and examining the mobility of countries within different groups across various time frames. The study also aims to uncover both β (beta) and σ (sigma) convergences during the periods before and after liberalization. The data for the study is collected from UNDP data sources. The results identified the presence of both β (beta) and σ (sigma) convergences during both pre and post-liberalization periods. Overall, this paper contributes to understanding the trends and convergence of HDI across a selected set of countries over a specific time period, shedding light on their socio-economic progress and potential investment opportunities. The combination of the new HDI calculation methodology and the investigation of convergence patterns adds novelty to this research. However, the study elaborates further on the implications of the findings and their practical applications for investors and policymakers.

Key Words: HDI, Mobility matrix, σ convergence, and β convergence.

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Introduction:

Initially, when development economics emerged as a separate stream in economic literature, economic development was thought to be synonymous with increased per capita income. It highlights how the understanding of economic development has shifted from being solely focused on per capita income to encompassing a broader sense of improvement in people's living conditions. This broader perspective acknowledges that economic development should not only consider financial aspects but also factors such as health, education, and overall well-being.

Originally, HDI was defined by Mahbub ul Haq as a composite index of well-being, constructed from measures of life expectancy, education, and per-capita income. Later, however, the measure was modified by United Nations Development Programme (UNDP). Various researchers provide a clear historical perspective on the evolution of development economics and the concept of economic development. Those studies indicate how the understanding of economic development has shifted from being solely focused on per capita income to encompassing a broader sense of improvement in people's living conditions. This broader perspective acknowledges that economic development should not only consider financial aspects but also factors such as health, education, and overall well-being.

The link between globalization and potential disparities in people's well-being across different regions is also thought-provoking. Globalization has led to both opportunities and challenges and assessing its impact on human development through the lens of HDI is a relevant avenue of research. Understanding how different countries' HDI values have changed during the post-reform period can shed light on whether globalization has contributed to a convergence or divergence in human development outcomes.

By exploring this relationship, our research aims to provide valuable insights into how economic reforms and globalization may have influenced the well-being of people in various parts of the world. This perspective adds depth to the study of development economics and offers a more holistic understanding of the impact of economic changes on human lives.

Review of Literature

This study is an attempt to highlight the related issues of HDI between the pre and post liberalization period. The literature review deals with the findings of various reports of UNDP,

the research studies, articles of researchers, economists and the comments of economic analysts.

Mahbub Ul Haq introduced the concept of the Human Development Index (HDI) in the 1990 edition of the Human Development Report by the United Nations. HDI is a widely used tool for ranking countries based on their socioeconomic performance. It takes into account factors related to education, health, and income. The HDI is published annually in the Human Development Report, which compiles and presents data at the country level. Prior to 2020, the HDI was defined as a composite index measuring well-being. It was constructed using indicators of life expectancy, education, and per-capita income. In 2020, the United Nations introduced a new version of the HDI. This new version is a more comprehensive composite index that measures a country's average achievements in three fundamental dimensions of human development. Longevity is measured by life expectancy at birth. Knowledge is measured by a combination of adult literacy rate and combined enrollment ratios in primary, secondary, and tertiary education. Standard of Living is measured by GDP per capita. The HDI value ranges between 0 and 1, with 0 indicating lower development and 1 indicating higher development.

According to Mahbub Ul Haq (1995), the new HDI is designed to expand people's choices in terms of both their social and economic well-being. It serves as a comprehensive measure that takes into account various dimensions of development. Haq highlighted the flexibility of the HDI estimation methodology, implying that it can adapt to different contexts and evolve with changing data and understanding of development. The new HDI is constructed from three core components: longevity (life expectancy), knowledge (education), and income (GDP per capita). Haq described the process in three steps. The first step involves defining a country's measure of deprivation for each of the three components (longevity, knowledge, and income). The minimum and maximum observed values for each component are determined across all countries. The deprivation measure ranges from 0 to 1, with 0 indicating the least deprived and 1 indicating the most deprived. The second step involves calculating the average of the deprivation measures for the three components. The third step is to calculate the HDI value. Haq's formula for HDI is (1 - average deprivation index), which provides a relative position of a country in terms of its development. Mahbub Ul Haq compared the HDI and Gross National Product (GNP) rankings of 173 countries. His findings underscored the importance of understanding the link between social and economic progress. He emphasized that focusing on income distribution within a society and its impact on people's lives is crucial. Haq's study

revealed that if a country's HDI rank is higher than its GNP per capita rank, it signifies accelerated growth based on human capital. Conversely, if a country's HDI rank is less favorable compared to its GNP per capita rank, it suggests income inequality and unequal distribution of national income among the population. Mahbub Ul Haq noted that the new HDI index allows for the measurement of other indices, including the Human Poverty Index and the Gender-related Development Index (GDI), which are important indicators to assess the well-being and development of a society.

Sakiko and Kumar (2003) view HDI as a straightforward method for measuring a country's well-being. They argue that HDI offers clarity to policymakers and the public, providing a clear idea of a country's development. The central aim of development, according to them, is to broaden people's choices and create an environment where they can lead healthy lives. HDI is seen as a tool that encompasses various dimensions of development, including social, economic, and political aspects, leading to an enhancement of people's lives.

Sagar and Najam (1998) critically evaluated the calculation of HDI and proposed modifications. While acknowledging HDI's superiority over income-based methods for evaluating a country's performance, they suggested several measures for calculating dimensional indices. They emphasize the need to consider inequality in evaluating the performance of dimensional indices and incorporating it into the HDI. They criticized the Human Development Report (HDR) for potentially losing its validity if HDI performance measures disconnect from reality and highlighted the importance of incorporating sustainability into the index. The impact of natural resources on national income and HDI, as well as the sustainability of such growth, are areas of concern.

Konya and Guisan (2008) argued that life expectancy and education, two components of HDI, should be measured relative to other countries, not just by comparing maximum and minimum values. They studied the possibility of human development convergence globally using the Human Development Trend from the United Nations Development Programme. They used σ and β convergence methods and found slow convergence between 1975 and 2004, with specific convergence among pre-2004 EU member countries and current EU members between 1995 and 2004.

Mazumdar (2002), Sutcliffe (2004), and Noorbakhsh (2006) found that measuring standard of living through the HDI provides a more comprehensive understanding of convergence among countries compared to relying solely on per capita income.

Barro and Sala-i Martin (1992, 1995) and other researchers explored economic forces that lead to convergence across regions and countries, including diminishing returns to capital, spatial capital and labor mobility, and diffusion of innovations and technologies. Barro and Sala-i Martin (1995) identified β-convergence as necessary but not sufficient for σ-convergence. β-convergence refers to the tendency of countries with lower initial income levels to experience higher growth rates, while σ-convergence refers to the reduction in income inequality over time.

Researchers like Sala-Martin (1996a, 1996b), Persson (1997), and Jones (2002) have used the standard deviation of log income (S) as a measure of dispersion when examining σ convergence. Other researchers like Abramotivz (1986), Holtz-Eakin (1993), Ferreira (2000), and Dawson and Sen (2007) have utilized the coefficient of variation of absolute income (C) as an alternative measure of dispersion in their analyses. This leads to the observation that there are two distinct measures of dispersion used in the context of σ convergence.

Friedman (1992) initially suggested that β and σ convergence could serve as substitutes for each other. However, Faiza A. Khan (2011) challenged this concept and analyzed both measures of convergence (β and σ) for various global regions over a significant period (1950-2008). Khan's analysis revealed that the relationship between σ convergence and β convergence is more complex. He proposed a trend equation involving logarithmic terms (lnt) to explain this relationship, concluding that the two measures of σ convergence differ from both the presence of σ-convergence and the relationship between β and σ convergences. Khan used both cross-sectional and panel data frameworks to estimate β convergence, indicating a more nuanced understanding of the relationship between these convergence measures.

Barro (1991), Mankiw et al. (1992), Dowrick and Nguyen (1989), and Barro and Sala-i-Martin (1992) identified convergence in various data sets by conducting cross-country regressions of observed growth rates on initial levels.Researchers have incorporated conditioning variables such as population growth, savings rate, and human capital to provide a more comprehensive understanding of convergence patterns.

Barro (1991) discovered convergence in income levels among 98 countries during the period 1960-1985.Mankiw et al. (1992) agreed with Barro's findings for OECD countries but found discrepancies for non-OECD countries.

The literature review highlights the complexities of measuring and understanding convergence using different methodologies and measures of dispersion. It also underscores the importance of empirical studies in assessing convergence patterns across countries and regions.

Objective of the Study:

The purpose of the research paper is to utilize a new methodology to calculate the Human Development Index (HDI) for 40 countries spanning the years 1980 to 2020. The study also aims to provide descriptive statistics for the selected countries based on their HDI values. Additionally, the research seeks to analyze the mobility patterns of various countries within different groups over different time frames. Finally, the study aims to uncover and analyze the convergence patterns exhibited by the selected countries based on their HDI values during the period from 1980 to 2020.

In summary, the specific objectives of the study include:

Calculating HDI Values: To compute the HDI values for 40 countries using a new methodology throughout the period from 1980 to 2020.

Descriptive Statistics: To present descriptive statistics that offer insights into the distribution and characteristics of the selected countries based on their HDI scores.

Analyzing Mobility Patterns: To determine and analyze the mobility patterns of different countries within various groups over different time frames. This involves assessing how countries transition in terms of their HDI ranks and values.

Sigma and Beta Convergence Analysis: To investigate the presence of sigma and beta convergence among the selected countries with respect to their HDI values. Sigma convergence refers to the reduction in disparities or dispersion among countries, while beta convergence focuses on the relationship between initial income levels and subsequent growth rates.

By pursuing these specific objectives, the study aims to contribute to a deeper understanding of human development trends, mobility patterns, and convergence dynamics for the selected countries during the specified time period.

Methodology:

The study is built upon secondary data sourced from the Human Development Report (HDR) provided by the United Nations Development Programme (UNDP). A total of 40 countries

were selected for analysis based on the availability of data. These countries were chosen to represent various levels of development and different geographical regions across the world. The selection process took into account both the representativeness of different development levels and regions as well as the availability of data from UNDP.

In accordance with the UNDP's Human Development Report of 2020, the Human Development Index (HDI) is formulated by integrating three crucial dimensions of life:

Life expectancy at birth: The average number of years a newborn is expected to live.

Mean years of schooling: The average years of education received by people aged 25 and older.

Expected years of schooling: The number of years of education a child entering school is expected to complete, assuming age-specific enrolment ratios remain constant.

Income (GNI per capita): Gross National Income per capita at purchasing power parity in US dollars.

In this new methodology, three separate indices are created to calculate the HDI using these dimensions. The study's reliance on the HDR data and the formulation of HDI based on these three dimensions aims to provide a comprehensive and multidimensional assessment of development across the chosen countries. This approach not only considers economic aspects but also incorporates educational attainment and health indicators, offering a broader perspective on development levels and patterns among the selected nations.

1. Life Expectancy Index (LEI) = $\frac{(\mathrm{LE} - min\,\mathrm{LE})}{(max\,\mathrm{LE} - min\,\mathrm{LE})}$

   …. (where LE is Life Expectancy)

2. Education Index (EI) = $\frac{\sqrt{\mathrm{MYSI}.\mathrm{EYSI}}}{\sqrt{max\mathrm{MYSI}.max\mathrm{EYSI}}}$

   [where

   a. Mean Years of Schooling Index (MYSI) = $\frac{\mathrm{MYS}}{max\,\mathrm{MYS}}$

   ……(MYS is Mean Years of Schooling)

   and

   b. Expected Years of Schooling Index (EYSI) = $\frac{\mathrm{EYS}}{max\,\mathrm{EYS}}$

……(EYS is Expected Years of Schooling)]

3. Income Index (II) = $\frac{(\ln(\text{GNIpc})-\ln(min\ \text{GNIpc}))}{(\ln(\max \text{GNIpc})-\ln(min\ \text{GNIpc}))}$

Finally, the HDI is calculated with the help of the following formula using the above three normalized indices: HDI = $\sqrt[3]{\text{LEI. EI. II}}$

For our study, we have taken data of LE, MYS, EYS and GNI pc for 40 countries around the world with a five year interval starting from 1980 to 2020. We have got the data for our research from the HDR of UNDP where the Life expectancy at birth (years) - Source: UN (2020). World Population Prospects: 2008 Revision. New York, Mean years of schooling (adults aged 25 years and above) - Source: Barro-Lee March 2020, Expected years of schooling - primary to tertiary (children of school entrance age) - Source: UIS March 2020 and GNI per capita (constant 2008 PPP US$) – calculated- Source: HDRO own calculations.

Firstly, we have calculated the HDI of those 40 countries using the new method of calculating HDI with the help of above mentioned formula at a five year interval from 1980 to 2020. Secondly, we have tried to find out some of the descriptive statistics for the selected countries based on their HDI and the existence of sigma convergence overtime.

Thirdly, we have ranked the countries overtime as per their HDI and have constructed rank wise mobility matrices for different time period in order to ascertain the mobility pattern of them within the different groups. In order to do so we have grouped the countries into six different groups according to their HDI levels, namely Extremely Low (EL), Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH).

And finally, after analyzing the mobility pattern of the selected countries we have tried to discover the existence of beta convergence in those countries from 1980 to 1995 and 1995 to 2020 using the following regression equations respectively:

Growth $8095_i = \alpha - \beta$ .log (HDI 80_i) + μ_i…..(1) and

Growth $9520_i = \alpha - \beta$ .log (HDI 95_i) + γ_i…..(2)

where log (HDI80_i) and log(HDI95_i) is the logarithm of country's HDI at time 1980 and1995 respectively. Growth$8095_i \equiv$ log (HDI95_i/ HDI80_i)/ 15 is the growth rate of HDI of i-th country between 1980 and 1995, Growth$9520_i \equiv$ log (HDI 20_i/ HDI 95_i)/ 25 is the growth rate of HDI of ith country between 1995 and 2020, (i= 1,2,3,…,40) and hence we have concluded with the

type of convergence of those 40 countries based on their HDI. In order to analyze the existence of beta convergence we have used SPSS software.

Result Analysis:

In our study, we have calculated the HDI of 40 countries using the new method of HDI calculation. The detailed results are shown in Table 1. From Table 1 we found a clear picture of the trend in HDI of 40 countries from 1980 to 2020. Here we have seen an increasing trend in HDI for most of the countries.

A few of them remain same during 2005 to 2020, like those of Australia, Canada, Denmark, Japan, Malaysia, Mauritius, New Zealand etc. and few of them have decreased over time like those of Central African Republic, Mali, South Africa etc. We also observed that the HDI of Nepal has increased very rapidly from 0.17 in 1980 to 0.4 in 2020. This might be due to the components of HDI i.e., Life expectancy, Education and Income. They increased substantially overtime. There is an increasing trend of those components for Nepal which might help to increase its HDI in such way.

Again, in case of South Africa we found that the Life expectancy and GNI pc have decreased over time which might be a reason to decrease the HDI from 0.57 in 1980 to 0.40 in 2020. The HDI of Bangladesh has increased from 0.21 in 1980 to 0.44 in 2020 which indicates an overall growth in all the components of HDI.

In Table 2 (a) we have provided some of the descriptive statistics during 1980-2020 for the data provided in Table 1. Also we have divided our entire study periods into two sub periods; one is from 1980-1995 and another is from 1995-2020 and we have found out the descriptive statistics for those two sub periods. These are discussed with the help of Table 2 (b) and Table 2 (c) respectively.

From Table 2 (a) we observed that the maximum values of HDI increased over time except a little decrease in 1995 and 2000. This might be the effect of globalization. The minimum values of HDI remained same over time. We also observed here that the standard deviation decreased throughout this period which indicates a fall in cross sectional dispersion among the selected countries, i.e., there is σ convergence.

In Table 2 (b), we found that standard deviation decreased over time which indicates the presence of σ convergence during 1980-1995. We also observed the increasing trend of maximum values of HDI overtime. Minimum values of HDI remained the same overtime.

Table 2 (c), showed the descriptive statistics for our second sub period i.e., from 1995-2020. Although the standard deviation has been increased little in 2000 and 2020, throughout the period it has decreased. This showed the existence of σ convergence too.

After that we have discussed the concept of sigma convergence with the help of Table 3 at five years interval overtime. According to Barro and Sala-i-Martin (1995) and Sala-i-Martin (1996), sigma convergence refers to a situation when the level of dispersion of real per capita income falls across a group of economies over time. With the help of this concept here we calculated the level of dispersion of HDI across a group of countries overtime and discovered the existence of sigma convergence. In Table 3 we observed that the value of Coefficient of Variation (CV) decreased over time indicating the existence of sigma convergence.

We know that lower the value of CV lower the level of dispersion around mean. Table 3 also showed that the value of CV decreased over time, i.e., the level of dispersion of HDI across a group of countries decreased over time. Only it increased a little in2020. This result clearly indicates the existence of sigma convergence of HDI overtime.

Next, we have ranked the countries as per their HDI and grouped them. The different groups as we mentioned in the methodology part are Extremely Low (EL), Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH). In Table 5 (a) we have tried to show the mobility pattern of the countries over the period between different groups of HDI namely.

Here we found that among all the countries that were in EL group in 1980, 66.67% of countries remained in EL group in 2020 whereas 33.33% of the countries shifted to VL group. Again, among the VL group countries in 1980, 44.44% of countries remained in VL group, 44.45% shifted to L and 11.11% shifted to M group in 2020. Countries belonging to L group in 1980, 10% moved to VL group, 50% remained in L group, 30% moved to M and 10% moved to H group in 2020. Similarly, among the M group countries in 1980, 75% moved to H group and 25% remained in M group in 2020. In the case of H group countries in 1980, 80% countries remained in H group and 20% moved to the VH group in 2020. As per the matrix, the countries that were in VH group in 1980 remained in the same group in 2020. There was no movement found for the VH group countries from 1980 to 2020.

Next, we have calculated and analyzed the mobility matrix in two parts for two different periods 1980-1995 and 1995 - 2020 which have been expressed here with the help of Table 5 (b) and Table 5 (c) respectively.

By considering Table 5 (b) where we mentioned the mobility of the selected countries between 1980 -1995, we found that the mobility pattern for the countries belonging to the EL group was more or less the same as Table 5 (a), i.e., during 1980-2020. There were a few little changes with the mobility pattern for the rest of the countries during 1980-1995. According to Table 5(b), in 1995, 66.67% of the countries moved from VL to L group and 33.33% remained in the VL group. For L group countries in 1980, 60% remained in L group in 1995 and 40% shifted to M group in 1995. Again, for M group countries in 1980, 75% moved to H group whereas 25% remained in M group in 1995. In 1980, among the H group countries, 90% countries remained in H group and 10% moved to VH group which pattern was slightly different from Table 5 (a), i.e., during 1980-2020. But the mobility pattern for the VH group remained same with that of Table 5 (b) which indicates that there was no mobility of the countries belonging to VH group during 1980-2020 and 1980-1995.

Table 5 (c) showed that no countries those were in EL and VL group in 1995, shifted to any other group in 2020. This indicates that there was no mobility among the countries belonging to EL and VL group during 1995-2020. Again, if we consider L group in 1995, 16.67% of the countries moved to VL group, 75% remained in L group and 8.33% shifted to M group in 2020. If we look at the M group countries in 1995, 20% moved to H group and 80% remained in M group in 2020. In case of H group in 1995, 92.31% countries remained in H group and 7.69% shifted to VH group in 2020 and for VH group countries again we found no mobility of the countries during 1995-2020.

After analyzing the mobility pattern of the selected countries in we have tried to find out the existence of β convergence of HDI for these countries from 1980-1995 and from 1995-2020 i.e., pre and post liberalization period. For that we have used the following regression equations respectively as discussed in methodology:

$\text{Growth } 8095_i = \alpha - \beta \log(\text{HDI } 80_i) + \mu_i$….. (1) and

$\text{Growth } 9510_i = \alpha - \beta \log(\text{HDI } 95_i) + \gamma_i$….. (2)

In Table 6 (a) we have shown the convergence analysis during 1980-1995 for the selected countries. Here we found the value of β is (-.109) which indicates the existence of β convergence within the selected countries during 1980-1995. Along with Table 6 (a) if we

consider Table 3, we found the existence of σ convergence during 1980-1995 among the selected countries. Here also $\sigma_{(t+T)} < \sigma_t$ (where t = 1980 and t+T = 1995).

Table 6 (b) represents the convergence analysis during 1995-2020 for the selected countries. The value of β here is (-.238) which proved the existence of conditional convergence within the selected countries during 1995-2020. During this period also there was cross sectional dispersion among the selected countries. We got this from Table 3 where it showed that $\sigma_{(t+T)} < \sigma_t$ (where t =1995 and t+T = 2020).

Therefore, from our study we discovered the existence of sigma as well as beta convergence for both i.e. pre and post reform period.

Conclusion:

In this study, we conducted an analysis of the Human Development Index (HDI) using the new methodology introduced by UNDP. Here's a summary of the key findings and conclusions:

HDI Calculation and Movement over Time:

We calculated the HDI for the selected countries using the new UNDP method.

We observed how the HDI values changed over time for these countries.

Conditional Convergence (β Convergence):

Based on our analysis, we noted that countries with initially low HDI tend to experience faster growth compared to countries with higher HDI. This dynamic leads to the convergence of HDI values among countries over time. This type of convergence, known as conditional convergence or β convergence, suggests that disparities in HDI levels between countries tend to diminish as time progresses.

Dispersion Convergence (σ Convergence):

We observed a decreasing trend in the dispersion of HDI values across the selected countries over time. This trend indicates that countries are moving closer together in terms of HDI values, suggesting the presence of σ convergence. σ convergence refers to the reduction of disparities among countries over time.

Globalization and Convergence Patterns:

We divided the entire study period into two sub-periods: before globalization and after globalization. Despite the division into sub-periods, we found that the convergence pattern among the selected countries remained consistent. Both σ convergence and β convergence were observed throughout the study period, including both sub-periods. This indicates that the introduction of globalization did not significantly alter the convergence pattern among the selected countries.

In conclusion, our study shows that over the analyzed period, there was both conditional convergence (β convergence) driven by countries with lower initial HDI growing faster, and dispersion convergence (σ convergence) indicating decreasing disparities among countries' HDI values. Furthermore, the findings suggest that the convergence pattern remained consistent before and after the era of globalization, implying that globalization did not notably influence the observed convergence dynamics among the selected countries.

Limitations of the Study:

In our study, we have acknowledged several limitations that affect the scope and depth of our research. Here's a summary of the limitations we have found:

Limited Country Selection:

Due to the availability of consistent data from UNDP, we were constrained to select only 40 countries for our study. While we aimed to represent different parts of the world, the restricted number of countries might limit the generalizability of our findings to a broader global context.

Short Time Period:

The study was conducted over a relatively short time frame of about 40 years. The limited duration of the study may impact our ability to capture long-term trends, changes, or convergence patterns that could occur over a more extended period. Longer time frames might provide a more comprehensive perspective on development trends and convergence dynamics.

Data Source Limitations:

The study relies on secondary data collected from UNDP. The unavailability of consistent data for more countries and over a longer time span constrained the scope of our analysis.

Generalizability:

The findings of our study might have limitations in terms of their applicability and relevance to a broader set of countries or regions due to the limited country selection and short time period.

External Factors:

The study may not account for various external factors that could influence development trends and convergence patterns, such as geopolitical events, policy changes, economic shocks, and technological advancements.

It's important to recognize these limitations as they provide context to the scope of our research and help interpret the significance and potential implications of our findings. While these limitations may impact the generalizability of our results, they also highlight opportunities for future research to address these constraints and further enrich the understanding of convergence patterns and development dynamics.

Future Research Possibilities:

This study has left with us some important future research possibilities. We have attempted to identify and analyze the mobility pattern of some selected countries and have done convergence analysis during pre- and post-reform periods based on their HDI. Some of the important future research possibilities of this study can be listed as follows:

- In the future, researchers can conduct the same analysis for per capita income too.
- Further, based on this study researchers can also make a comparison of the ranking of countries based on their GNI pc and HDI.
- The different indicators of HDI can be analyzed to discuss the well-being of a nation.
- The same study can be conducted for each country as well as each state separately to find out their developmental status.

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Appendix

Table 1: Trends in HDI for some selected countries

Country	HDI								
	1980	1985	1990	1995	2000	2005	2020	2015	2020
Argentina	0.75	0.75	0.75	0.76	0.74	0.76	0.78	0.76	0.76
Australia	0.93	0.93	0.93	0.97	0.96	0.97	0.97	0.95	0.95
Austria	0.85	0.86	0.88	0.87	0.86	0.87	0.88	0.89	0.89
Bangladesh	0.21	0.23	0.30	0.34	0.34	0.41	0.44	0.45	0.49
Botswana	0.46	0.53	0.62	0.62	0.44	0.48	0.49	0.59	0.6
Canada	0.93	0.95	0.96	0.94	0.91	0.92	0.92	0.89	0.9
Central African Republic	0.23	0.24	0.27	0.27	0.17	0.20	0.11	0.15	0.12
Chile	0.69	0.70	0.75	0.76	0.75	0.79	0.80	0.78	0.79
China	0.37	0.43	0.48	0.54	0.56	0.62	0.66	0.65	0.67
Colombia	0.60	0.61	0.63	0.65	0.63	0.66	0.68	0.67	0.67
Denmark	0.90	0.91	0.90	0.89	0.87	0.89	0.89	0.91	0.91
Egypt	0.40	0.46	0.52	0.55	0.55	0.58	0.60	0.58	0.58
France	0.83	0.84	0.87	0.88	0.87	0.89	0.90	0.87	0.87
Ghana	0.34	0.33	0.39	0.42	0.36	0.39	0.38	0.41	0.42
Hong Kong, China (SAR)	0.81	0.84	0.88	0.87	0.84	0.88	0.90	0.91	0.94
Iceland	0.88	0.89	0.90	0.89	0.89	0.92	0.90	0.92	0.93
India	0.31	0.34	0.39	0.42	0.40	0.46	0.47	0.48	0.49
Indonesia	0.38	0.43	0.48	0.53	0.48	0.56	0.59	0.58	0.59
Iran (Islamic Republic of)	0.48	0.52	0.58	0.61	0.61	0.66	0.69	0.68	0.68
Japan	0.91	0.92	0.92	0.91	0.90	0.92	0.92	0.89	0.9
Korea (Republic of)	0.69	0.74	0.81	0.84	0.84	0.88	0.90	0.87	0.88
Malaysia	0.60	0.64	0.68	0.71	0.70	0.74	0.74	0.72	0.73
Mali	0.02	0.01	0.16	0.19	0.13	0.20	0.16	0.25	0.25
Mauritius	0.58	0.60	0.66	0.67	0.66	0.69	0.69	0.63	0.65
Nepal	0.17	0.22	0.30	0.34	0.33	0.38	0.40	0.44	0.45
New Zealand	0.92	0.91	0.91	0.92	0.90	0.93	0.93	0.89	0.89

Norway	0.93	0.94	0.95	0.95	0.95	0.97	0.97	0.75	0.76
Pakistan	0.31	0.34	0.37	0.40	0.39	0.45	0.46	0.48	0.48
Philippines	0.56	0.55	0.59	0.59	0.58	0.62	0.63	0.57	0.59
Rwanda	0.19	0.20	0.02	0.01	0.02	0.24	0.24	0.39	0.4
Saudi Arabia	0.61	0.64	0.69	0.70	0.69	0.74	0.75	0.73	0.72
South Africa	0.57	0.58	0.65	0.66	0.51	0.48	0.40	0.54	0.54
Sri Lanka	0.56	0.58	0.60	0.61	0.60	0.64	0.66	0.67	0.68
Sweden	0.91	0.91	0.91	0.92	0.93	0.92	0.92	0.92	0.93
Switzerland	0.95	0.94	0.94	0.91	0.90	0.91	0.91	0.93	0.94
Thailand	0.53	0.56	0.59	0.62	0.59	0.62	0.63	0.66	0.69
Turkey	0.50	0.54	0.60	0.62	0.62	0.66	0.67	0.72	0.74
United Kingdom	0.86	0.86	0.87	0.90	0.85	0.88	0.87	0.89	0.89
United States	0.95	0.97	0.97	0.95	0.93	0.93	0.93	0.88	0.88
Zimbabwe	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Calculated from UNDP data

Table 2(a): Descriptive Statistics (1980-2020)

	N	Minimum	Maximum	Mean	Std. Deviation
1980	40	.0000	.9511	.591468	.280549
1985	40	.0000	.9621	.606383	.274386
1990.	40	.0000	.9645	.638025	.266888
1995.	40	.0000	.9597	.649811	.258693
2000.	40	.0000	.9571	.630953	.267985
2005.	40	.0000	.9661	.664075	.248064
2020.	40	.0000	.9601	.668289	.258027
2015	40	.0000	.9478	.6778	.225413
2020	40	.0000	.9463	.6870	.215423
Valid N (listwise)	40				

Source: Calculated from UNDP data

Table 2 (b): Descriptive Statistics (1980-1995)

	N	Minimum	Maximum	Mean	Std. Deviation
1980	40	.0000	.9511	.5914	.2805499
1985	40	.0000	.9621	.6063	.2743867
1990.	40	.0000	.9645	.6380	.2668895
1995.	40	.0000	.9597	.6498	.2586939
Valid N (listwise)	40				

Source: Calculated from UNDP data

Table 2 (c): Descriptive Statistics (1995-2020)

	N	Minimum	Maximum	Mean	Std. Deviation
1995.	40	.0000	.9597	.6498	.25869
2000.	40	.0000	.9571	.6309	.26798
2005.	40	.0000	.9661	.6640	.24806
2020.	40	.0000	.9601	.6682	.25802
2015.	40	.0000	.9478	.6778	.225413
2020.	40	.0000	.9463	.6870	.215423
Valid N (listwise)	40				

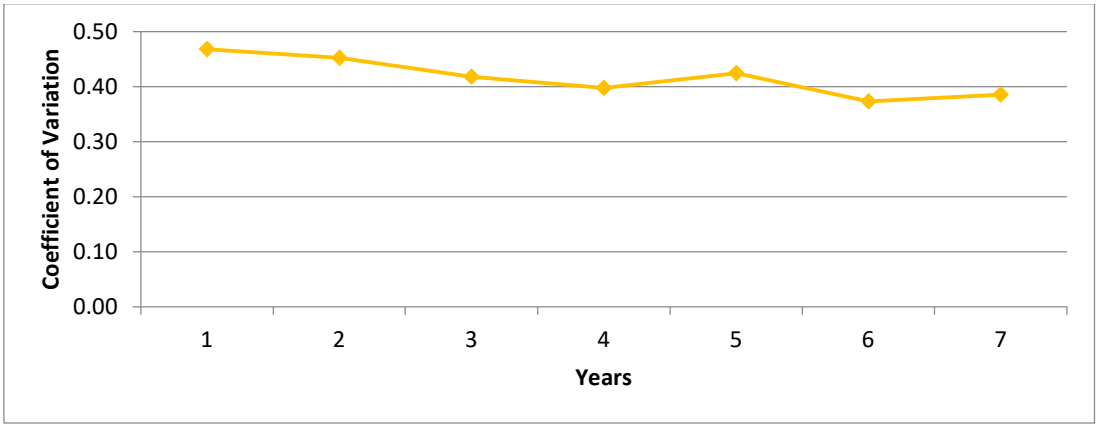
Source: Calculated from UNDP data

Table 3: Sigma (σ) Convergence (1980-2020)

	Year								
	1980	**1985**	**1990**	**1995**	**2000**	**2005**	**2020**	**2015**	**2020**
SD	0.28	0.27	0.27	0.26	0.27	0.25	0.26	0.23	0.22
MEAN	0.59	0.61	0.64	0.65	0.63	0.66	0.67	0.67	0.68
CV	0.47	0.45	0.42	0.40	0.42	0.37	0.39	0.34	0.32

Source: Calculated from UNDP data

Figure 1: Sigma Convergence across countries during 1980-2020



Source: Calculated from UNDP data

Table 4: Ranking of the countries as per their HDI overtime

	Rankings				
Year	**1980**	**1990**	**2000**	**2020**	**2020**
Country	**HDI**	**HDI**	**HDI**	**HDI**	**HDI**
Argentina	15	16	17	17	17
Australia	4	5.5	1	1.5	1
Austria	12	12	12.5	13	12.5
Bangladesh	36	35.5	35	31.5	35
Botswana	28	23	31	34	31
Canada	4	2.5	5	7.5	5
Central African Republic	35	37	37	39.5	37
Chile	16.5	17	16	16	16
China	31	30.5	27	25.5	27
Colombia	19.5	22	21	22.5	21
Denmark	9	9	10.5	13	10.5
Egypt	29	29	28	27	28
France	13	14	10.5	10.5	10.5
Ghana	32	32.5	34	31.5	34
Hong Kong, China (SAR)	14	12	14.5	7.5	14.5
Iceland	10	10	9	13	9
India	33.5	32.5	32	30	32
Indonesia	30	30.5	30	29	30
Iran (Islamic Republic of)	27	28	23	20.5	23
Japan	7.5	5.5	7	4.5	7
Korea (Republic of)	16.5	15	14.5	10.5	14.5
Malaysia	19.5	19	18	19	18
Mali	39.5	38	38	38	38
Mauritius	21	20	20	20.5	20
Nepal	38	35.5	36	35	36

New Zealand	6	7.5	7	4.5	7
Norway	4	2.5	2	1.5	2
Pakistan	33.5	34	33	33	33
Philippines	23.5	26.5	26	28	26
Rwanda	37	39.5	39.5	37	39.5
Saudi Arabia	18	18	19	18	19
South Africa	22	21	29	36	29
Sri Lanka	23.5	24.5	24	24	24
Sweden	7.5	7.5	3.5	7.5	3.5
Switzerland	1.5	4	7	7.5	7
Thailand	25	26.5	25	25.5	25
Turkey	26	24.5	22	22.5	22
United Kingdom	11	12	12.5	15	12.5
United States	1.5	1	3.5	3	3.5
Zimbabwe	39.5	39.5	39.5	39.5	39.5

Source: Calculated from UNDP data

Table 5 (a): Mobility Matrix of the countries during 1980-2020

1980-2020						
	EL	**VL**	**L**	**M**	**H**	**VH**
EL	66.67	33.33	0	0	0	0
VL	0	44.44	44.45	11.11	0	0
L	0	10	50	30	10	0
M	0	0	0	25	75	0
H	0	0	0	0	80	20
VH	0	0	0	0	100	0

Source: Calculated from UNDP data

Table 5 (b): Mobility Matrix of the countries during 1980-1995

1980-1995						
	EL	**VL**	**L**	**M**	**H**	**VH**
EL	66.67	33.33	0	0	0	0
VL	0	33.33	66.67	0	0	0
L	0	0	60	40	0	0
M	0	0	0	25	75	0
H	0	0	0	0	90	10
VH	0	0	0	0	100	0

Source: Calculated from UNDP data

Table 5 (c): Mobility Matrix of the countries during 1995-2020

1995-2020						
	EL	**VL**	**L**	**M**	**H**	**VH**
EL	100	0	0	0	0	0
VL	0	100	0	0	0	0
L	0	16.67	75	8.33	0	0
M	0	0	0	80	20	0
H	0	0	0	0	92.31	7.69
VH	0	0	0	0	0	100

Source: Calculated from UNDP data

Table 6 (a): Convergence Study during 1980-1995

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.109[a]	.012	-.014	.5621882413

a. Predictors: (Constant), V11

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.145	1	.145	.460	.502[b]
	Residual	12.010	38	.316		
	Total	12.155	39			

a. Dependent Variable: V10

b. Predictors: (Constant), V11

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.217	.116		-10.479	.000
	V11	-.156	.229	-.109	-.678	.502

a. Dependent Variable: V10

Source: Calculated from UNDP data

Table 6 (b): Convergence Study during 1995-2020

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.238[a]	.057	.032	1.0326737567

a. Predictors: (Constant), Log (HDI95i)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.435	1	2.435	2.283	.139[b]
	Residual	40.524	38	1.066		
	Total	42.959	39			

a. Dependent Variable: Growth 9520i

b. Predictors: (Constant), Log (HDI 95i)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.355	.182		-7.434	.000
	V13	-.386	.255	-.238	-1.511	.139

a. Dependent Variable: Growth 9510i

Source: Calculated from UNDP data