JOURNAL OF DEVELOPMENT ECONOMICS AND FINANCE
Vol. 2, No. 1, 2021, pp. 177-201

URL : www.arfjournals.com

Exploring SHDI: A New Approach for Measuring Sustainable Human Development

Abdullah Al Mahmud & Mashrefa Tarannum

Bangladesh, Emails: zohaan71.du.eco@gmail.com; tarannummashrefa20@gmail.com

Article History

Received : 13 April 2021
Revised : 18 May 2021
Accepted : 20 May 2021
Published : 5 June 2021

Key words

Sustainable development, Environment, SHDI, Gini, Gender gap

Abstract: From its inception in 1990, HDI has been outspoken as well as criticized in measuring human development across the countries. This paper has investigated the validity of the customary HDI and proposed a new form of measurement for human development across the countries that include the opportunity costs of repeated economic development modern economics is dealing with. This paper has included important critiques of HDI that are being discussed and suggested a new form of measuring human development- sustainable human development index (SHDI)- with a weighted valuation of environmental effects, income inequality, and gender gap- three notable costs of high and repeated industrialization through high economic growth. Sustainable Human Development Index (SHDI) takes the three key indices of HDI and suggests a new sub-index- EPIG valuation for measuring the sustainability of development, which consists of Environmental Performance index, Gini index, Global Gender Gap Index. The study has covered a total number of 146 countries for creating the SHDI yearly index of 2020 and then compared the respective values of HDI and SHDI. The findings of the study imply a significant change in the country index, as well as their global rankings which conclude 141 out of 146 attributed countries (96.5%), have scored less in SHDI with respect to HDI.

Introduction

The measurement procedure of HDI has been questioned since the beginning of its implementation. The notion of the human development index was to enable people to expand their freedom by estimating a global comparative human development framework. Three variables (health, education, income) along with

their sub-indicators were used to enumerate this index. Some of HDI criticisms are related to the idea of measuring human development by a conceptually limited composite index. Some regard it as being limited in measuring human development by the quality and limitation of data (Murray 1993, Srinavsan 1994), while some others have been critical about the technical property of this. An alternative measure for estimating HDI is proposed which takes the distance between the standardized actual values of the indicators as a measure of HDI by Majumdar, K. (2003). The new index was labeled as a New approach to HDI or NHDI. The proposed estimate sheds the light on the fact that the gap between the rich and the poor countries concerning human development is much wider than it has been evidenced by the HDI estimate of the UNDP.

To find how countries have been doing after incorporating education and health domain to income, Hilani (2012) found the Pearson Ran Correlation between GNI per capita and HDI Index. Though the rank correlation has turned out to be pretty high (.98), some countries give us a new mode of observing this phenomenon. Despite there being a better position on income index, some countries lost a huge fraction of scores when they are ranked based on HDI. A super-efficiency model is proposed by Pan *et al* (2013) where the integrated multiple inputs and outputs of each country into a relative efficiency score. Their empirical study showed that 75% of the sample countries had efficiency ranking notably different from their HDI ranking. For example, countries with the top ranking in HDI (Canada, Sweden) had roughs the worst ranking in the super efficiency score. Also, Sen (1999) argued that these variables are not sufficient conditions for development. So, Ali (2012) suggests incorporating other good indices such as the Gender Discrimination Index, Inequality Indexes to take in the count before making any general policy recommendation. Measuring a country's development with these three indices of HDI has been roughly criticized and disputed from many aspects, Desai (1991), has criticized HDI that three indicators are seen as substitutes in HDI measuring. Instead, he suggested a log additive form of development measurement which restricts substitutability. Goremely (1995) argues that the choice of per capita income will influence HDI and its rankings. Wolf *et al.* (2009) and Taner *et al* (2010) have empirically suggested that the countries have been misclassified by the HDI. In brief, most previous studies have attempted to build a more justifiable measurement of HDI.

In particular, per capita income can no longer be justified as the dominant indicator for measuring development given its conceptual flaws (NÜbler; 1995).

She however suggested that it has been possible to demonstrate that the measurement method could be improved in many places. The measurement concept must be comprehensive to be valid. The HDI measures human development only incompletely, as it confines itself to only social and one economic dimension and ignores the cultural, political, and most importantly environmental dimension (Irmgard 1995).

HDI has played a considerable role in reshaping the idea of development, yet we cannot overemphasize its contribution by taking its indicator for granted as UNDP itself has been exceptionally receptive to criticism of HDI- "The HDI should be seen as evolving and improving rather than as something cast in stone. It is also an exercise in which like many of its users as possible should actively participate." (UNDP 1993: 104). In 1987, the World Conference on Environment and Development published their report entitled 'our common future (WCED 1987), often known as Brundtland report, where the term sustainable development was used widely. The report defined it as Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Even though environmental concerns were explained in the report with the ongoing rate of serious pollution and natural resource usage, HDI, which takes development to another dimension from an economic point of view, didn't address any of the opportunity cost of polluting the environment, climate change or global warming whatsoever. Human population growth and its economic development have certainly an effect on the rate of deforestation in our biodiversity hotspot. S. Jha & k. S. Bawa (2005) analyzed this effect by taking the dataset from 1980 to 1990. They argued that when population growth was high and human development was low, there was a high rate of deforestation. But when human development was high and population growth was low, there was a low rate of deforestation. Per capita co2 emissions rate has been considered as a key phenomenon for modern environmental economics and environmentalists suggest to rethink about the co2 emissions from fossil fuel combustion. Extrapolating the HDI Costa *et al* (2014) showed that to achieve a better HDI score, a high rate of cumulative co2 emissions is necessary following a Development as Usual approach (DAU). Analyzing a different dataset of growth and co2 emissions rate (per capita) from 1980 t0 2002 Michael *et al* (2004) argued, over the years, there's a positive correlation between CO2 emissions per capita and GDP per capita except for the US & UK who was industrialized first.

HDI has been well accepted as a summary measure of human development capabilities and development, but it's not yet adjusted to the weighted inequality it is creating, and it does not measure the income inequality as well as the misallocation of resources (Milorad Kovacevic, 2010). The conceptual difficulties and unavailability of the disaggregated data have been given as the major cause for not adjusting the HDI for inequality. Douglas a. Hicks (1997) constructed a framework of solution HDI is concerned for, in terms of distributional inequality of three indices of HDI-income, health (Longevity), and education. Inequality-Adjusted Human Development Index (IAHDI) has adjusted the rationale of adjusting inequality in terms of measuring HDI.

Apart from Inequality in income allocation, there's another big concern that is being neglected in the original HDI measuring- the gender gap. According to Shawn and Glenn (2010), although gender inequality is decreasing around the world, faster population growth in some countries is slightly slowing down this rate of decrease. Due to faster economic growth with diverse domains across the countries, a high chance of low gender inequality, or even no gender inequality is heading up and this is increasing the gender gap across the countries. Anand and Sen (1995) argued this investigation of exploring men-women share in the economy should link to the Gender-equity-sensitive-indicators (GESI) which implies an equity-sensitive development measurement. But these gender-equity measurements have limited validity too and they have some functional errors. Dijkstra and Hanmer (2000) drew a comparative analysis of GDI's (Gender-related Development Index) and RSW after analyzing all the indices.

All these studies mentioned above have analyzed, at maximum, a part of the concerns HDI is criticized about. Some criticized the inequality current development generating process is creating, some adjusted the inequality, some academics are concerned about the environmental cost of development i.e. carbon dioxide emissions and deforestation due to industrialization, some academicians have tried to focus on gender inequality, some tried to form a new dimension of measurement of human development and capabilities. This study has tried to connect all those concerns in a single dimension and show a new form of weighted and adjusted human development measuring tool where the three notable opportunity cost of development (Environmental cost of development, Gini inequality, and gender-based inequality or gap) are widely measured. The study will show, then, the comparative valuation in Human Development Index (HDI) and our proposed global index (Sustainable

Human Development Index-SHDI) for all 146 countries that are covered in this study.

Concepts & Components of SHDI

As mentioned earlier that the measurement process of human development has not seen unquestionably evident for measuring human development, it also has been repeatedly asked for newer weights or addition to its original components of human development measurement. This analogy of different measures has interested policymakers and development economists till now, and Human Development Report (HDR) itself does offer to measure human development from different aspects, i.e: inequality-adjusted, gender inequality valuation, etc.

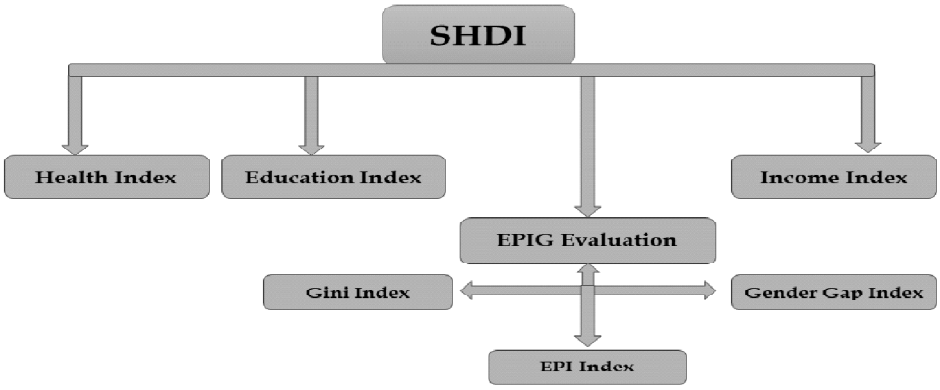
But these indicators, themselves, do give a favor to the politicians and governments as HDI is widely discussed for its original components (the original methods of HDI calculation with three main indices), where other measurements of human development are ignored. Like the Gini index based inequality-adjusted HDI or IAHDI. But just showing a country's Gini valuation to measure its reconstitution for income inequality doesn't give the solutions, neither does the gender inequality index.

Since the first exploration of the HDI report in 1990, it had three dimensions of measuring human development: a long and healthy life, education, and a decent standard of living. As the recent changes took place in the measurement indices, now four indices have been used to show the global human development progress under these three original components: Life Expectancy at birth (long and healthy life), mean years of schooling of population ages 25 and over (knowledge), expected years of schooling for children (knowledge); Gross National Income (GNI) per capita adjusted by purchasing power parity (PPP) (standard of living).

This study offers a new component to measure human development along with these three original indices, that is, EPIG Index which refers to combined progress in facing the three most vital opportunity costs (trade-offs) of repeated economic growth- Income inequality in the economy, environmental performance challenges, and gender inequality based on the share of economic stakeholders.

The first step of calculating the newly proposed SHDI, likewise the HDI, is to create four different separate indices for each of the four dimensions of SHDI. Then four different indices (health index, education index, income index, and the

Figure 1



last one is, our proposed, EPIG evaluation index) are used to calculate the global SHDI.

SHDI-1: Long and Healthy Life: It is completely derived from the original components of HDI and measured in the same way. According to HDR, the long and healthy life dimension uses life expectancy at birth as its indicator, defined as "the number of years a newborn infant could expect to live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life" (UNDP, 2010. P.224). It is basically calculated using a Minimum value of 20 years and a maximum value of 85 years, adopted in 2014 HDR.

SHDI-2: Education: It is calculated just the same way it is calculated in HDI, taking 0 year as minimum and 15 years as maximum for mean years of schooling whereas 0 year as a minimum and 18 years as maximum for expected years of schooling was taken.

SHDI-3: Decent Standard of Living: The decent standard of living measured is SHDI by using the data of the respective country's Gross National Income (GNI) Per capita income. The lowest per capita GNI is set at 100 US dollars and the highest per capita GNI is bounded at 75,000 US dollars.

SHDI -4: EPIG Evaluation: The proposed SHDI differs with HDI only in this section which offers a weighted method of measuring human development by employing the opportunity costs of the repeated growth. As mentioned above, this EPIG evaluation index consists of three different measures:

SHDI-4.1: Environmental Performance (Environmental performance Index): To measure the trade-off of the repeated growth over the environment, SHDI uses

the EPI index to show the progress of the respective country's environmental performance.

SHDI-4.2: Income Inequality (Gini Index Valuation): Gini Index is used to show the income inequality across the countries, taking the denominator form of the Gini values. The denominator formula has been used after setting a perfect income equality Gini at .20 (Yong *et al*; 2012)

SHDI-4.3: Gender Gap Evaluation (Global Gender Gap Report): To measure this index's respective performance, this study imported the global gender gap report (GGGR) that empirically shows more than 150 countries' performance in gender gap diminishing and suggests a cross-country wise referendum for more progress in eliminating the gender-based disparity.

Data source

Dataset for this study is retrieved from different sources, as mentioned below:

1. Data on Health index or life expectancy index was retrieved from UNDESA (2019b).
2. Data on expected years of schooling was retrieved from UNESCO Institute for Statistics (2019), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys, and OECD (2018)
3. Data on Minimum years of schooling was retrieved from UNESCO Institute of Statistics (2019), Barro and Lee (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys, and OECD (2018).
4. Data on Gross National Income (GNI) Per capita was retrieved from World Bank Data Indicators (WDI Indicators-2019a), IMF (2019), United Nations Statistics Division (2019b).
5. Data on environmental performance index are directly used from Environment Pollution Index (EPI), as a score, published in 2019 by Yale University.
6. Data on Income Inequality Index is retrieved from Gini Index, from World Bank Data Indicators (WDI Indicators -2019a), also from UNDP Human Development Report published for 2019 (at inequality-adjusted human development section).

7. Dataset of Gender Gap Report is retrieved from the Global Gender Gap Report (2020), published by-yearly by World Economic Forum.

Some other graphs and tables are used in the appendix section, at the very at the end of the study, which is retrieved or calculated from different sources as mentioned below there in the specific graphs.

Measurement & Aggregation of SHDI

Before the measurement process is showed, the minimum and maximum values for each index or sub-index are presented in the table 2.1:

Table 2.1

Dimension	*Indicator*	*Minimum*	*Maximum*
Health	Life Expectancy (Years)	20	85
Education	Mean years of schooling	0	15
	Expected years of schooling	0	18
Standard of Living	GNI per capita (PPP 2018 $)	100	75,000
EPIG	Gini	20 (Perfect Gini)	

For Health Index, just the same as HDI, equation 1 is applied using the actual values of cross country (value observed in the country) and the values of minimum and maximum values presented in table 2.1

$$Health\ Index = \frac{Actual\ value - minimum\ value}{Maximum\ value - minimun\ value} \quad (1)$$

For Education Index, equation 2.1, 2.2, 2.3 are applied using the values observed in the countries and the minimum and maximum values presented in table 2.1:

$$Mean\ \ years\ of\ \ schooling\ index = \frac{Actual\ value - minimum\ value}{Maximum\ value - minimum\ value} \quad (2.1)$$

$$Expected\ \ years\ of\ \ schooling\ index = \frac{Actual\ value - minimum\ value}{Maximum\ value - minimum\ value} \quad (2.2)$$

$$Education\ Index = \frac{Mean\ \ years\ of\ \ schooling\ index + Expected\ \ years\ of\ \ schooling\ index}{2} \quad (2.3)$$

For income index, GNI per capita is used to measure the standard of living just like HDI. Following equation 3 is applied using the minimum and maximum values presented in table 2.1:

$$Income\ Index = \frac{\ln(Actual\ value) - \ln(minimum\ value)}{\ln(Maximum\ value) - \ln(minimum\ value)} \tag{3}$$

For EPIG Evaluation Index, it is first divided into three different indices.

1. EPI Index, published by Yale University, which is ranged between 0 and 1. Analyzing the performance of the environment in the respective countries EPI gives a value index which will directly be used to show the Impact of growth or industrialization on the environment.

EPI Evaluation = Respective values of the countries in EPI [0<EPI <1] (4.1)

2. Then the Gini index will be used to measure the income inequality this repeated growth and industrialization is creating. Using the table 2.1's perfect equality Gini score (.20), mgd (maximum Gini denominator) is set at 5. Now, taking each respective country's Gini value, each country's respective Gini denominator value will then be calculated and after dividing it with the mgd, the Gini evaluation will be added in SHDI. Following equation (4.1) will be used to Calculate the Gini evaluation:

$$Gini\ evaluation\ (GI) = \frac{1}{gini\ value\ (of\ x\ country)}\%mgd \tag{4.2}$$

3. Gender Gap evaluation: for this index the same techniques and methods will be followed as we did in environment evaluation index section or EPI. Global Gender Gap Report, published by—annually by World Economic Forum, will be used in this section to measure the overall gender gap. It shows the gender gap in educational attainment, economic share and participation, health service getting, and finally political empowerment gap between the gender races created by this growth centric human development.

Gender Gap Evaluation (GGE) = Respective country values in GGGR [0<GGE<1] (4.3)

Aggregation of EPIG is quite different in SHDI. Environmental performance (EPI Index) will carry half of the EPIG, and Gini evaluation and gender inequality evaluation each will carry one-fourth of the EPIG respectively. So, the following equation (4.3) will be applied to score the EPIG:

$$EPIG\ Evaluation\ Index = \frac{2}{4}(EPI) + \frac{1}{4}(GI) + \frac{1}{4}(GGE)\ \ [0 < EPIG < 1] \quad (4.3)$$

Aggregation formula for SHDI: Once all these four aforementioned indices have been generated (Health Index, Education Index, Income Index, and EPIG Index), the SHDI score for respective country's will be calculated by taking the root four of the multiplied indices. The following formula will be used to find the SHDI (Sustainable Human Development Index):

$$\text{SHDI Score} = \sqrt[4]{Health\ Index * Education\ Index * Income\ Index * EPIG}$$

Example of calculating the SHDI

This part of the study illustrates how the SHDI can be calculated for one country-in this case, Spain.

Table 2.1: Spain's Indicator Values of SHDI]

Dimension	*Indicator*	*Values*
Health	Life Expectancy (Years)	83.4
Education	Mean years of schooling	9.8
	Expected years of schooling	17.9
Standard of Living	GNI per capita (PPP 2018 $)	35,041
EPIG	EPI Score	.783 (78.30)
	Gini Value	.362 (55.24)
	Gender Gap Report Value	.795 (79.50)

SHDI score calculation for Spain, of 2018

Step 1: each dimension index calculation

$$\text{SHDI 1- Life Expectancy Index} = \frac{83.4 - 20}{85 - 20} = 0.975384$$

$$\text{SHDI 2.1 - Mean years of schooling index} = \frac{9.8 - 0}{15 - 0} = 0.653$$

$$\text{2.2-Expected years of schooling index} = \frac{17.9 - 0}{18 - 0} = 0.994$$

$$\text{Education Index} = \frac{.6533 + 9944}{2} = 0.8235$$

$$\text{SHDI 3- Income Index} = \frac{\ln(35,041) - \ln(100)}{\ln(75,000) - \ln(100)} = 0.8855051$$

SHDI 4.1- EPI Index = .7830

$$\text{SHDI 4.2- Gini Evaluation} = \frac{1}{.3620} / 5 = 0.554861$$ [mgd is found by taking denominator of perfect income inequality point, 0.20]

SHDI 4.3- Gender Gap Evaluation (GGGR Index) =.795

$$\text{SHDI 4= EPIG} = \frac{2}{4}(EPI) + \frac{1}{4}(GI) + \frac{1}{4}(GGGR)$$

$$= \frac{2}{4}(.7830) + \frac{1}{4}(.5524) + \frac{1}{4}(.795) = 0.753$$

Step 2: aggregating the dimension indices and producing the SHDI score

$$SHDI\ Index = \sqrt[4]{Health\ Index * Education\ Index * Income\ Index * EPIG}$$

$$\sqrt[4]{.975384 * .8235 * .8855051 * .72835} = .843$$

Global Sustainable Human Development Index '2020

Using the features mentioned above, the study has produced an index that covers 146 countries globally. In the table 3.1, relevant scores of the countries in SHDI as well as their HDI scores are mentioned and a comparative statistic between these two global indices is shown at the end of each row. For a simplistic analysis, all the sub-index values are too included in the table 3.1.

Table 3.1

Country Name	*SHDI Rank*	*EPI score*	*Gini score*	*GGGR*	*EPIG*	*HDI*	*SHDI*	*% Change*
Norway	**1**	77.70	0.727	0.842	0.781	0.954	0.907	-0.049
Switzerland	**2**	81.50	0.619	0.779	0.757	0.946	0.895	-0.054

contd. table 3.1

Country Name	*SHDI Rank*	*EPI score*	*Gini score*	*GGGR*	*EPIG*	*HDI*	*SHDI*	*% Change*
Sweden	**3**	78.70	0.685	0.82	0.770	0.937	0.892	-0.048
Denmark	**4**	82.50	0.709	0.782	0.785	0.93	0.892	-0.041
Iceland	**5**	72.30	0.719	0.877	0.761	0.938	0.890	-0.051
Finland	**6**	78.90	0.738	0.832	0.787	0.925	0.888	-0.040
Germany	**7**	77.20	0.631	0.787	0.740	0.939	0.885	-0.058
Ireland	**8**	72.80	0.629	0.798	0.721	0.942	0.881	-0.065
Netherlands	**9**	75.30	0.709	0.736	0.738	0.933	0.880	-0.057
United Kingdom	**10**	81.30	0.602	0.767	0.749	0.92	0.874	-0.050
Australia	**11**	74.90	0.559	0.731	0.697	0.938	0.871	-0.072
Austria	**12**	79.60	0.656	0.744	0.748	0.914	0.869	-0.049
Belgium	**13**	73.30	0.722	0.75	0.735	0.919	0.869	-0.054
Luxembourg	**14**	82.30	0.592	0.725	0.741	0.909	0.864	-0.050
New Zealand	**15**	71.30	0.615	0.799	0.710	0.921	0.863	-0.063
Slovenia	**16**	72.00	0.787	0.743	0.743	0.902	0.859	-0.047
Canada	**17**	71.00	0.576	0.772	0.692	0.922	0.858	-0.069
Japan	**18**	75.10	0.623	0.652	0.694	0.915	0.854	-0.067
France	**19**	80.00	0.612	0.781	0.748	0.891	0.853	-0.043
Czech Republic	**20**	71.00	0.772	0.706	0.725	0.891	0.846	-0.050
United States	**21**	69.30	0.482	0.724	0.648	0.92	0.843	-0.084
Spain	**22**	74.30	0.552	0.795	0.708	0.893	0.843	-0.056
Singapore	**23**	58.10	0.503	0.724	0.597	0.935	0.836	-0.106
Malta	**24**	70.70	0.680	0.693	0.697	0.885	0.834	-0.058
Israel	**25**	65.80	0.514	0.718	0.637	0.906	0.830	-0.084
Italy	**26**	71.00	0.565	0.707	0.673	0.883	0.825	-0.066
Estonia	**27**	65.30	0.612	0.751	0.667	0.882	0.823	-0.067
Slovak Republic	**28**	68.30	0.755	0.718	0.710	0.857	0.818	-0.046
Greece	**29**	69.10	0.556	0.701	0.660	0.872	0.813	-0.067
Poland	**30**	60.90	0.649	0.736	0.651	0.872	0.811	-0.071
Cyprus	**31**	64.80	0.588	0.692	0.644	0.873	0.809	-0.073
Lithuania	**32**	62.90	0.535	0.745	0.634	0.869	0.803	-0.076
Portugal	**33**	67.00	0.563	0.744	0.662	0.85	0.798	-0.061
Latvia	**34**	61.60	0.585	0.785	0.650	0.854	0.798	-0.066
Hungary	**35**	63.70	0.658	0.677	0.652	0.845	0.792	-0.063
United Arab Emirates	**36**	55.60	0.615	0.655	0.596	0.866	0.789	-0.089
Croatia	**37**	63.10	0.643	0.72	0.656	0.837	0.788	-0.059
Kuwait	**38**	53.60	1.010	0.65	0.683	0.808	0.775	-0.041

contd. table 3.1

Country Name	*SHDI Rank*	*EPI score*	*Gini score*	*GGGR*	*EPIG*	*HDI*	*SHDI*	*% Change*
Belarus	**39**	53.00	0.787	0.746	0.648	0.817	0.771	-0.056
Romania	**40**	64.70	0.557	0.724	0.644	0.816	0.769	-0.058
Brunei Darussalam	**41**	54.80	0.494	0.686	0.569	0.845	0.765	-0.094
Chile	**42**	55.30	0.429	0.723	0.565	0.847	0.765	-0.096
Bahrain	**43**	51.00	0.588	0.629	0.559	0.838	0.757	-0.096
Argentina	**44**	52.20	0.493	0.746	0.571	0.83	0.756	-0.089
Bulgaria	**45**	57.00	0.535	0.727	0.600	0.816	0.756	-0.074
Serbia	**46**	55.20	0.702	0.736	0.635	0.799	0.755	-0.056
Kazakhstan	**47**	44.70	0.727	0.71	0.583	0.817	0.751	-0.081
Russian Federation	**48**	50.50	0.531	0.706	0.562	0.824	0.749	-0.091
Montenegro	**49**	46.30	0.627	0.71	0.566	0.816	0.745	-0.088
Albania	**50**	49.00	0.690	0.769	0.610	0.791	0.741	-0.063
Saudi Arabia	**51**	44.00	0.436	0.599	0.479	0.857	0.741	-0.135
Uruguay	**52**	49.10	0.506	0.737	0.556	0.808	0.736	-0.089
Oman	**53**	38.50	0.651	0.602	0.506	0.834	0.736	-0.118
Qatar	**54**	37.10	0.487	0.629	0.464	0.848	0.729	-0.140
Costa Rica	**55**	52.50	0.414	0.782	0.562	0.794	0.728	-0.083
Barbados	**56**	45.60	0.426	0.749	0.522	0.813	0.728	-0.105
Malaysia	**57**	47.90	0.488	0.677	0.531	0.804	0.725	-0.099
Bahamas, The	**58**	43.50	0.477	0.72	0.517	0.805	0.721	-0.105
Mauritius	**59**	45.10	0.559	0.665	0.531	0.796	0.720	-0.096
Ukraine	**60**	49.50	0.800	0.721	0.628	0.75	0.717	-0.044
Panama	**61**	47.30	0.401	0.73	0.519	0.795	0.715	-0.101
North Macedonia	**62**	55.40	0.562	0.711	0.595	0.759	0.714	-0.059
Iran, Islamic Rep.	**63**	48.00	0.490	0.584	0.509	0.797	0.712	-0.106
Turkey	**64**	42.60	0.477	0.635	0.491	0.806	0.712	-0.117
Mexico	**65**	52.60	0.461	0.754	0.567	0.767	0.711	-0.073
Armenia	**66**	52.30	0.595	0.684	0.581	0.76	0.711	-0.065
Bosnia and Herzegovina	**67**	45.40	0.606	0.712	0.557	0.769	0.709	-0.078
Georgia	**68**	41.30	0.528	0.708	0.515	0.786	0.707	-0.100
Azerbaijan	**69**	46.50	0.699	0.687	0.579	0.754	0.706	-0.064
Algeria	**70**	44.80	0.725	0.634	0.564	0.759	0.705	-0.072
Colombia	**71**	52.90	0.402	0.758	0.555	0.761	0.703	-0.076
Thailand	**72**	45.40	0.548	0.708	0.541	0.765	0.702	-0.083
Ecuador	**73**	51.00	0.447	0.729	0.549	0.758	0.699	-0.077

contd. table 3.1

Country Name	*SHDI Rank*	*EPI score*	*Gini score*	*GGGR*	*EPIG*	*HDI*	*SHDI*	*% Change*
Sri Lanka	**74**	39.00	0.503	0.68	0.491	0.78	0.695	-0.109
Brazil	**75**	51.20	0.375	0.691	0.523	0.761	0.693	-0.090
Peru	**76**	44.00	0.462	0.714	0.514	0.759	0.689	-0.093
Tunisia	**77**	46.70	0.610	0.644	0.547	0.739	0.685	-0.072
Moldova	**78**	44.40	0.772	0.757	0.604	0.711	0.683	-0.040
Jordan	**79**	53.40	0.593	0.623	0.571	0.723	0.682	-0.057
Dominican Republic	**80**	46.30	0.438	0.7	0.516	0.745	0.680	-0.088
China	**81**	37.30	0.518	0.676	0.485	0.758	0.678	-0.106
Lebanon	**82**	45.40	0.629	0.599	0.534	0.73	0.675	-0.075
Venezuela, RB	**83**	50.30	0.426	0.713	0.536	0.726	0.673	-0.073
Jamaica	**84**	48.20	0.440	0.735	0.535	0.726	0.673	-0.074
Mongolia	**85**	32.20	0.619	0.706	0.492	0.735	0.665	-0.095
Paraguay	**86**	46.40	0.410	0.683	0.505	0.724	0.662	-0.086
Philippines	**87**	38.40	0.499	0.781	0.512	0.712	0.656	-0.079
Botswana	**88**	40.40	0.375	0.709	0.473	0.728	0.654	-0.102
Egypt, Arab Rep.	**89**	43.30	0.629	0.629	0.531	0.7	0.653	-0.067
Fiji	**90**	34.40	0.545	0.678	0.478	0.724	0.653	-0.099
Bolivia	**91**	44.30	0.455	0.734	0.519	0.703	0.652	-0.073
Indonesia	**92**	37.80	0.525	0.7	0.495	0.707	0.647	-0.085
Maldives	**93**	35.60	0.521	0.646	0.470	0.719	0.646	-0.101
South Africa	**94**	43.10	0.317	0.78	0.490	0.705	0.644	-0.087
Kyrgyz Republic	**95**	39.80	0.733	0.689	0.554	0.674	0.642	-0.048
Iraq	**96**	39.50	0.678	0.53	0.499	0.689	0.636	-0.077
Vietnam	**97**	33.40	0.567	0.7	0.484	0.693	0.633	-0.086
El Salvador	**98**	43.10	0.526	0.706	0.524	0.667	0.628	-0.059
Morocco	**99**	42.30	0.506	0.605	0.489	0.676	0.624	-0.078
Tajikistan	**100**	38.20	0.588	0.626	0.495	0.656	0.611	-0.068
Nicaragua	**101**	39.20	0.433	0.804	0.505	0.651	0.611	-0.061
Namibia	**102**	40.20	0.338	0.784	0.482	0.645	0.600	-0.070
Timor-Leste	**103**	35.30	0.697	0.662	0.516	0.626	0.597	-0.047
Cabo Verde	**104**	32.80	0.424	0.725	0.451	0.651	0.594	-0.088
India	**105**	27.60	0.560	0.668	0.445	0.647	0.589	-0.089
Guatemala	**106**	31.80	0.414	0.666	0.429	0.651	0.587	-0.099
Bhutan	**107**	39.30	0.535	0.635	0.489	0.617	0.582	-0.056
Honduras	**108**	37.80	0.396	0.722	0.469	0.623	0.580	-0.069
Bangladesh	**109**	29.00	0.617	0.726	0.481	0.614	0.578	-0.059

contd. table 3.1

Country Name	*SHDI Rank*	*EPI score*	*Gini score*	*GGGR*	*EPIG*	*HDI*	*SHDI*	*% Change*
Lao PDR	**110**	34.80	0.549	0.731	0.494	0.604	0.574	-0.049
Eswatini	**111**	33.80	0.388	0.703	0.442	0.608	0.561	-0.077
Cambodia	**112**	33.60	0.650	0.694	0.504	0.581	0.561	-0.035
Nepal	**113**	32.70	0.610	0.68	0.486	0.579	0.554	-0.043
Vanuatu	**114**	28.90	0.532	0.638	0.437	0.597	0.552	-0.075
Zambia	**115**	34.70	0.350	0.731	0.444	0.591	0.550	-0.069
Kenya	**116**	34.70	0.490	0.671	0.464	0.579	0.548	-0.054
Ghana	**117**	27.60	0.460	0.673	0.421	0.596	0.546	-0.083
Zimbabwe	**118**	37.00	0.463	0.73	0.483	0.563	0.542	-0.037
Myanmar	**119**	25.10	0.525	0.665	0.423	0.584	0.539	-0.077
Angola	**120**	29.70	0.468	0.66	0.431	0.574	0.534	-0.069
Pakistan	**121**	33.10	0.597	0.564	0.456	0.56	0.532	-0.050
Cameroon	**122**	33.60	0.429	0.686	0.447	0.563	0.531	-0.056
Rwanda	**123**	33.80	0.458	0.791	0.481	0.536	0.522	-0.027
Papua New Guinea	**124**	32.40	0.477	0.635	0.440	0.543	0.515	-0.051
Uganda	**125**	35.60	0.467	0.717	0.474	0.528	0.514	-0.027
Tanzania	**126**	31.10	0.529	0.713	0.466	0.528	0.512	-0.031
Nigeria	**127**	30.80	0.465	0.635	0.429	0.534	0.506	-0.053
Mauritania	**128**	27.70	0.613	0.614	0.445	0.527	0.505	-0.041
Senegal	**129**	30.70	0.496	0.684	0.449	0.514	0.497	-0.033
Madagascar	**130**	26.50	0.469	0.719	0.430	0.521	0.496	-0.047
Benin	**131**	30.00	0.418	0.658	0.419	0.52	0.493	-0.052
Lesotho	**132**	28.00	0.369	0.695	0.406	0.518	0.487	-0.059
Togo	**133**	29.50	0.464	0.615	0.417	0.513	0.487	-0.050
Cote d'Ivoire	**134**	25.80	0.482	0.606	0.401	0.516	0.484	-0.061
Malawi	**135**	38.30	0.447	0.664	0.469	0.485	0.481	-0.008
Ethiopia	**136**	34.40	0.512	0.705	0.476	0.47	0.472	0.003
Guinea	**137**	26.40	0.593	0.642	0.441	0.466	0.460	-0.014
Gambia, The	**138**	27.90	0.557	0.628	0.436	0.466	0.458	-0.017
Congo, Dem. Rep.	**139**	36.40	0.475	0.578	0.445	0.459	0.456	-0.008
Liberia	**140**	22.60	0.567	0.685	0.426	0.465	0.455	-0.022
Burkina Faso	**141**	38.30	0.567	0.635	0.492	0.434	0.448	0.032
Mozambique	**142**	33.90	0.370	0.723	0.443	0.446	0.445	-0.002
Sierra Leone	**143**	25.70	0.588	0.668	0.443	0.438	0.439	0.003
Mali	**144**	29.40	0.606	0.621	0.454	0.427	0.434	0.015
Burundi	**145**	27.00	0.518	0.745	0.451	0.423	0.430	0.016
Chad	**146**	26.70	0.462	0.596	0.398	0.401	0.400	-0.002

Findings of the Study

By the statistic this study has analyzed, for year 2020, the global mean sustainable human development index - SHDI (based on these 146 countries dataset's weighted-average) score stands at 68.03. The mean value of HDI for these same countries for this year is 72.97. The difference between these two indices average is 6.47% which simply means that, on average, human development is supposed to be lower when the trade-offs of repeated economic growth (environment and income inequality) and the social cost of male-dominant economic strategy (gender gap) are counted in the index.

Table 3.1 shows the 2020 global index scores of all 146 countries covered in this newly formed index. The changes in the top 20 countries are huge, ranging from the highest percentage fall of 10.60% (Singapore) to the lowest percentage fall of 3.96% (Finland). Overall highest percentage fall is 13.975% (Qatar) and the lowest percentage fall is 3.17% (Burkina Faso).

Table 3.2: Key statistical estimates of the index

Variable	*HDI*	*SHDI*	*% Change*
Mean	.7297671	.6803169	-.0647404
Standard Deviation	.1486356	.1326158	.0289285
Variance	.0220925	.017587	.0008369
Skewness	-.4209197	-.1813803	.5580136
Kurtosis	2.110705	2.029061	3.989562

This year's SHDI has a breakthrough point in terms of percentage change (between SHDI and HDI) across the countries. Out of 146 countries covered in this year's SHDI report, 141 countries have seen their performance in human development reduced which is 96.5% of the whole attributed countries. Only 5 countries, out of these 146, have seen a progress in their comparative value judgment between SHDI and HDI.

All the top ten sustainably developed countries in this overall index are from the Western Europe region alone; they are Norway, Switzerland, Sweden, Denmark, Iceland, Finland, Germany, Ireland, Netherlands, and United Kingdom (with their scores ranging from .907 to .874). On the contrary, all the ten least-sustainably developed countries are from the Sub-Saharan African region alone. They are Chad,

Burundi, Mali, Sierra Leone, Mozambique, Burkina Faso, Liberia, Congo Democratic Republic, The Gambia, and Guinea (with their scores ranging from .400 to .460).

Potential contribution of SHDI

This functional form of measuring human development with a new index, Sustainable Human Development Index, is indeed more flexible than the HDI and it allows a new way of thinking in policymaking. The global SHDI is a set of international comparisons between the countries so that countries can realize whether their current progress of human development is sustainable or not – combining the opportunity costs of the development (i.e. CO2 emissions, deforestation, fuel oil emissions, income inequality in the economies, the gender-based gap in the economies and so on). This method of development measurement ensures that countries may, at least, realize where their respective development is leading them. This index is useful as it ponders policy-oriented statement for countries, a rethinking for the development goals probably. This rethinking must consist of policymakers' attention as well as their government's goodwill for the respective country's long run economic future.

This index must create an exercise of reinvestigating the development pathways and goals -nationally and internationally. Environmentalists all around the globe, the normative economists who have been speaking out for inequality for years and never been heard by the policymakers, and the women who have been fighting for their legitimate equal rights everywhere -from the workforce to decision making, from their households to their access to opportunity -will be getting a systematic approach to know their focuses and can redirect their respective country's development goals in a more sophisticated way.

Limitations of the SHDI

The study is constrained to a data limitation. Value of some of the indicators, i.e. gender inequality values or Gini, were unavailable for some countries. In those cases, we have used the techniques suggested by James and Gary (2010), analyzing the time-series-cross-section (TSCS) dataset from its other different relevant indicators. The index certainly does not capture many of the socio-economic aspects of human development -like political freedom, social freedom choice, economic wellbeing quality, social safety, health service quality, and so on due to the data unavailability of these factors. Although these factors are desirable to compute in an index to show human development, important data constraints for these variables prevented this

study from doing so. And again, likewise HDI, this process of human development measurement is not free from questions and critiques - questions that may arise from diverse themes- from lack of quality judgment to the substitutability assumptions, from the mixture of variables we used to normalization of indicators we tried to lessen, from a lack of more rigorous functional form of measuring this index to lack of proper understanding of values we used to compute the SHDI. Yet our proposed SHDI ensures a composite measurement of human development from what's going on in the economy to what will be coming next as the consequences. It gives a form of nominal rethinking on global development measurement pathways.

Conclusion

The sustainable human development index provides a comprehensive overview of global human development with an account of the environment, Gini, and gender gap. The index then weighted these additional figures and investigated for a better tool for measuring sustainable human development across the countries. This index offers a benchmarking tool for tracking the global progress of human development and analyzing the index-based lacking across the countries. This year's SHDI report produced in this study finds that the global human development is, on average, actually 6.47% falling behind the current human development index (HDI) If the new yet necessary three dimensions are taken into account for conventional measurement. This study also showed all the 146 countries' performance in every aspect of the variables covered under the index, which might suggest the policymakers and governments switch their emphasis into something more important depending on their respective performance on respective sub-index. In the appendix section of this study, in relevance with the HDI investigating, some graphs are shown for a better understanding of the current global human development (HDI) growth pathway and how it is creating a more centralized, more unhabitable global economy instead of creating a human development balance.

The study however continues to highlight the strong positive correlation between EPIG and SHDI which means that the more the country's performance in these three components (environment, Gini, gender gap) are, the more the country's performance in the overall sustainable human development index (SHDI). Although, the study addressed a wide performance variation of the countries that are due to a diverse array of underlying causes - for instance - economic cost of having a strong environment, trade-offs of a less gender gap on productivity, less capital-intensive

investment strategy because of a less inequality within the economy. In an effort to draw a complete picture of human development across the countries, this study has provoked the necessary thoughts on the sustainability of the current economic betterment by measuring its instant cost and trade-offs.

Reference

A. Asongu, S. (2018). CO2 emission thresholds for inclusive human development in Sub-Saharan Africa. *AGDI Working Paper*.

A. Geske Dijkstra & Lucia C. Hanmer. (2000). Measuring Socio-Economic GENDER Inequality: Toward an Alternative to the UNDP Gender-Related Development Index. *Feminist Economics, 6*(2), 41-75.

Al-Hilani, H. (2012). HDI as a Measure of Human Development: A Better Index than the Income Approach? *IOSR Journal of Business and Management, 2*(5), 24-28.

Alkire, S. (2010, May). Human Development: Definitions, Critiques, and Related Concepts.

Anand & Sen. (n.d.). Gender Inequality in Human Development: Theories and Measurement.

Antony, Rao, & Balakrishna. (2001). Suitability of HDI for Assessing Health and Nutritional Status. *Economic and Political Weekly, 36*(31), 2976-2979.

Arfanuzzaman, M. (2016). Impact of CO2 Emission, Per Capita Income and HDI on Environmental Performance Index: Empirical Evidence from Bangladesh. *International Journal of Green Economics, 10*(3/4).

Berik, G. (2018). Toward more inclusive measures of economic well-being: Debates and practices. *ILO future of work research paper series*.

Cahill, M. B. (2005). Is the Human Development Index Redundant? *Eastern Economic Journal, 31*(1), 1-5.

Comim, F. (2016). Beyond the HDI? Assessing alternative measures of human development from a capability perspective. *2016 UNDP Human Development Report Background Paper*.

Costa L, Rybski D, Kropp JP. (2011). A Human Development Framework for CO2 Reductions. (U. o. Juan A. Añel, Ed.) *PLoS ONE, 12*(6).

Crafts, N. (2002). The Human Development Index, 1870-1999: Some revised estimates. *European Review of Economic History, 6*(3), 395-405.

Desai, M. (1991). Human development: Concepts and measurement. *European Economic Review, 35*(2-3), 350-357.

(2020). *Environmental Performance Index*. Yale Center for Environmental Law & Policy.

F. Dorius & Firebaugh. (2010). Trends in Global Gender Inequality. *Social Forces, 88*(5), 1941-1968.

Ferrant, G. (2015, June). How Do Gender Inequalities Hinder Development? Cross-Country Evidence. *Annals of Economics and Statistics, 117-118*, 313-352.

Gaye & Klugman *et al.* (2016, December). Measuring Key Disparities in Human Development: The Gender Inequality Index.

Giray, Selay & Ergut, Ozlem. (2014). Multivariate analysis of countries according to subdimensions of human development and gender inequality indices. *Eurasian Journal of Social Sciences, 2*(3), 48-62.

(2020). *Global Gender Gap Report.* Geneva, Switzerland: World Economic Forum.

Gormely, P. J. (1995). The Human Development Index in 1994: Impact of Income on Country Rank. *Journal of Economic and Social Measurement, 21*, 253-267.

Grubb, Müller, & Butler. (2004). *The relationship between carbon dioxide emissions and economic growth* University of Cambridge .

Hicks, D. A. (1997). The Inequality-Adjusted Human Development Index: A Constructive Proposal. *World Development, 25*(8), 1283-1298.

(2018). *Human Development Indices and Indicators- 2018 Statistical Update.* New York City: UNDP.

(2019). *Human Development Report.* New York City: UNDP.

Jha & K. S. Bawa. (2006). Population Growth, Human Development, and Deforestation in Biodiversity Hotspots. *Conservation Biology, 20*(3), 906-912.

Kumar, A. K. (1996). UNDP's Gender-Related Development Index: A Computation for Indian States. *Economic and Political Weekly, 31*(14), 887-895.

Lind, N. (2004). Values Reflected in the Human Development Index. *Social Indicators Research, 66*(3), 283-293.

Livingstone *et al.* (2016, February). Perspectives on the Global Disparity in Ecological Science. *BioScience, 66*(2), 147-155.

Mazumdar, K. (2003). A New Approach to Human Development Index. *Review of Social Economy, 61*(4), 535-549.

Michel *et al* (2004). The relationship between carbon dioxide emissions and economic growth. *Oxbridge study on CO2-GDP relationships, Phase 1 result.* Department of Applied Economics, University of Cambridge.

Neumayer, E. (2001). The human development index and sustainability — a constructive proposal. *Ecological Economics, 39*, 101–114.

Noorbakhsh, F. (1998). The Human Development Index: Some Technical Issues and Alternative Indices. *Journal of International Development, 10*, 589-605.

Nübler, I. (1995). The human development index revisited. *Intereconomics Review of European Economic Policy,* 30(4), 171-176.

Pan, fan, & Wu. (2013a). Does Human Development Index Provide Rational Development Rankings? Evidence from Efficiency Rankings in Super Efficiency Model. *Social Indicators Research, 116*(2), 647–658.

Permanyer, I. (2010, January). The Measurement of Multidimensional Gender Inequality: Continuing the Debate. *Social Indicators Research, 95*(2), 181-198.

Permanyer, I. (2010). The Measurement of Multidimensional Gender Inequality: Continuing the Debate. *Social Indicators Research, 95*(2), 181-198.

(2019). *Perspectives on Global Development 2019*. OECD Development Centre .

Salas-Bourgoin, M. A. (2014). A proposal for a modified Human Development Index. *CEPAL REVIEW*, 29-44.

Sandica, Dudian, & Stefanescu. (2018). Air Pollution and Human Development in Europe: A New Index Using Principal Component Analysis. *Sustainability, 10*.

Taoa, Yong; Wub, Xiangjun; & Lic, Changshuai. (2012). Rawls' Fairness, Income Distribution and Alarming Level of Gini Coefficient.

Wolff H., Chong H., Auffhammer M. (2009). Human Development Index: Are Developing Countries Misclassified?

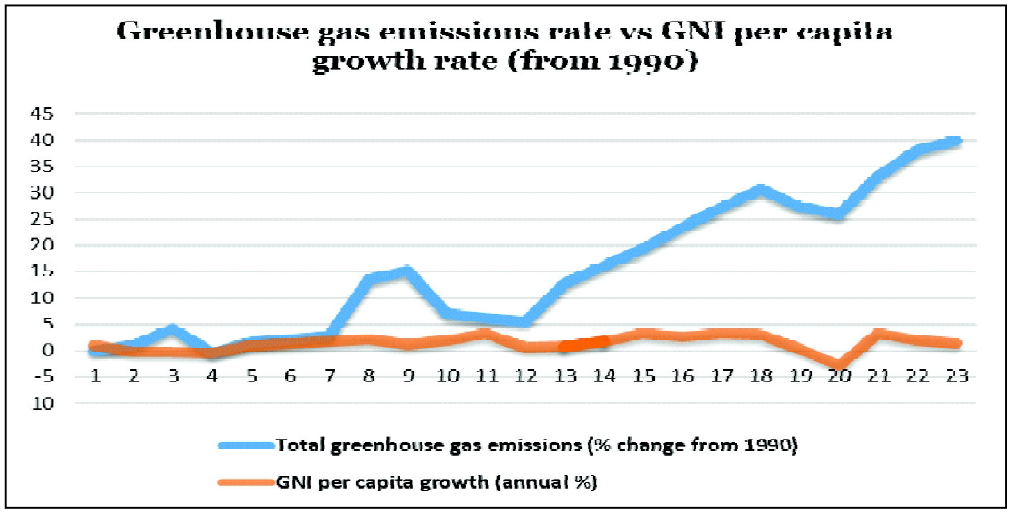
Zambrano, E. (2014). An axiomatization of the human development index. *Social Choice and Welfare, 42*(4), 853-872.

To cite this article:

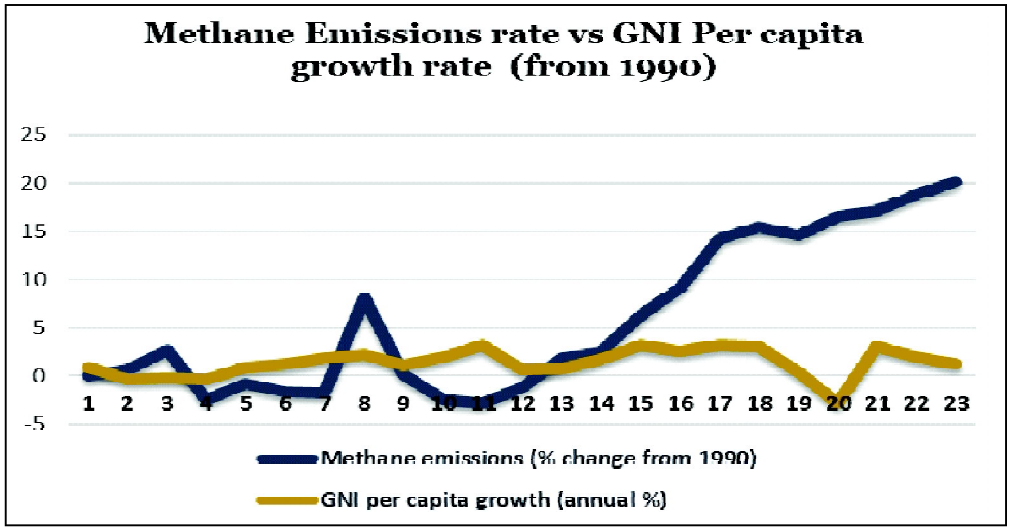
Abdullah Al Mahmud & Mashrefa Tarannum (2021). Exploring SHDI: A New Approach for Measuring Sustainable Human Development *Journal of Development Economics and Finance*, Vol. 2, No. 1, pp. 177-201

Appendix

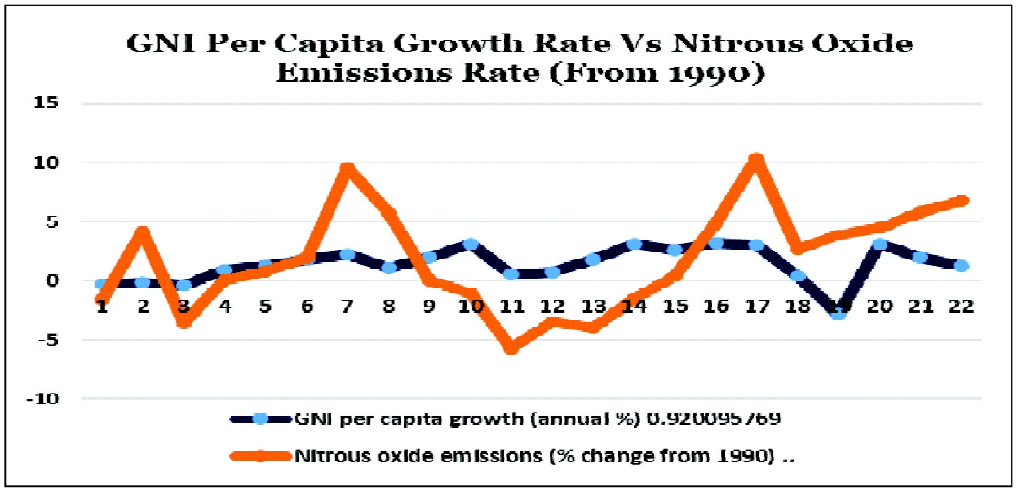
1. Graphical relation between the Greenhouse emissions rate and GNI per capita growth rate annually (from 1990)



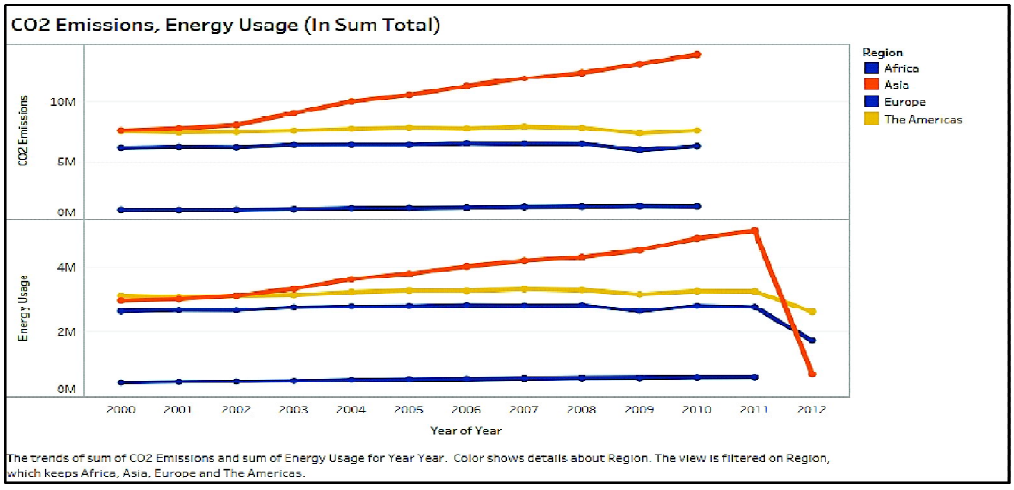
2. Methane gas emissions rate and GNI per capita growth rate:



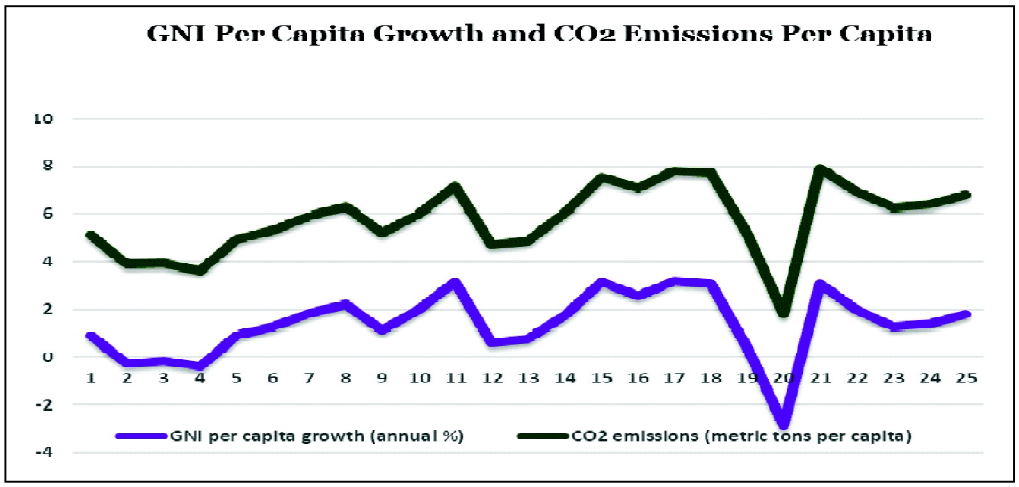
3. GNI Per capita growth rate vs Nitrous emissions rate (from 1990):



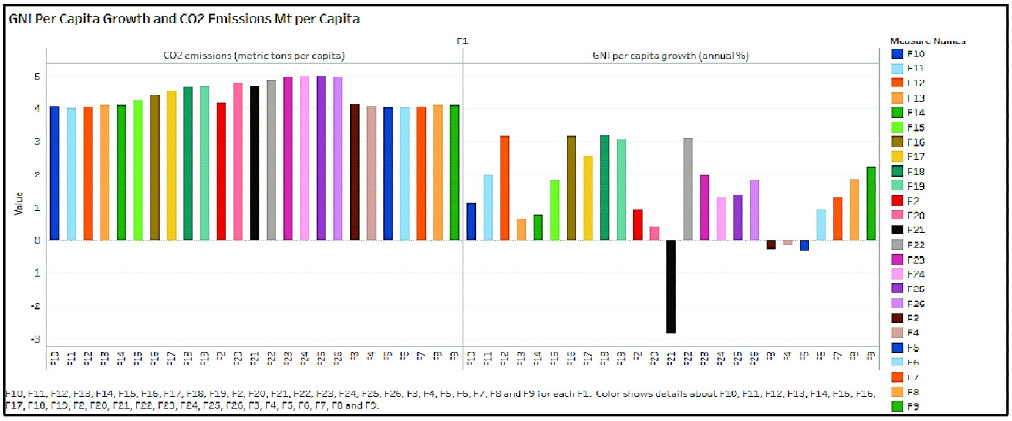
4. CO2 emissions, Energy usage (in total sum) by regions:



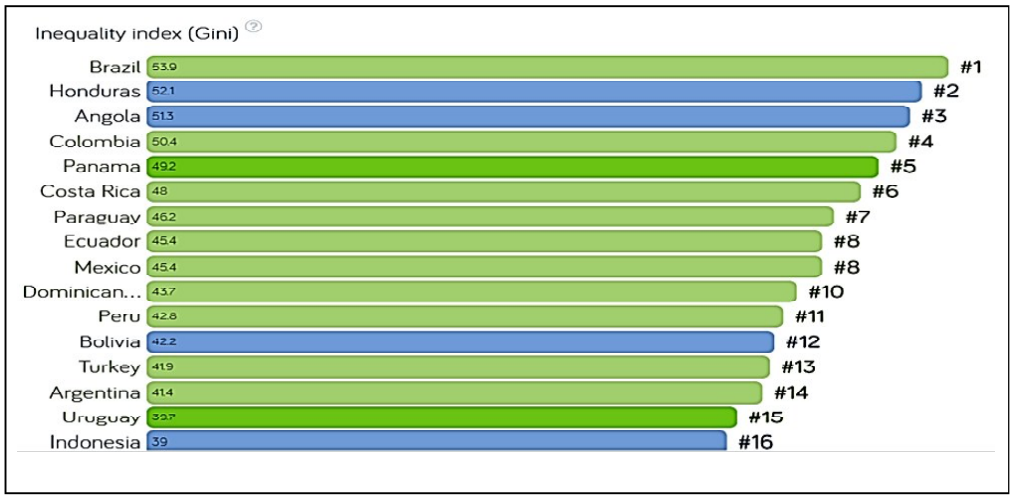
5. GNI Per capita growth and CO2 emissions (Metric tons per capita):



6. Wood removal (In Cubic Meters) by Top 10 Countries:



7. Global Gini Inequality Index Ranking by Income Groups:



Here, 2 out of 16 top countries with income inequalities are high income countries, 10 are upper middle-income countries, the rest 4 are lower-middle income countries. (No low-income country is in top 16)!

8. Global Gender gap closed and years needed to close fully (by region):