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New Approaches to Human Development Index

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Abstract

This paper extends the convergence concept to the broader measures of development and standard of living. For this purpose, a development index was constructed as an alternative to Human Development Index of United Nations Development Programme by considering the critiques that were directed to it. Actually, we have four arguments in the approaches proposed as an alternative to the HDI. These are as follows: Calculating HDI without logarithmic transformation of the income dimension. Instead of multiplying the values of health, education and income, collecting the square roots of these three components in order to reach HDI. Include the gini coefficient in HDI calculations. Taking the arithmetic average of these three components by using the HDI formula in 1994 HDR again. Two types of convergence (β and σ convergence) test was constructed with the new index and results indicated that there exists less convergence in the development levels of the 95 countries in the sample for the years 1980-2015 against the results from original HDI which favors more convergence.

Keywords: *Human Development Index, Convergence, Education, Health*.

Introduction

Interest in the concept of "development" has increased with the rise in the popularity of economic development since 1960s. This interest has created a necessity of defining of where development stands in economics. Economic growth and economic development are often used interchangeably, however, economic development actually refers to the improvement of living standards, while economic growth is only interested in the quantitative growth of an economy. Giving higher importance to qualitative factors than quantitative factors in comparing or assessing countries, gave rise a need for a new definition of human development. In order to address this need, "Human Development Index" (HDI) has been created by United Nations Development Programme (UNDP).

UNDP's approach to human development is based on the Amartya Kumar Sen's "capacity approach" (Sen, 2005) as a conceptual framework. Sen argues that the improvements in living standards constitute the basis of development. He defines capacity approach as the increase in the number of things that human beings can do by forcing the boundaries of himself (Fukuda-Parr, 2003). The ultimate goal of economic activities is to make people to live a better life. Therefore, calculating the life people lived makes more sense than calculating the income they earned. This perspective distinguishes the HDI from income-based approach (Anand and Sen, 1994).

The HDI is a summary mixed index that measures human development in three dimensions: "health: long and high quality life", "education: access to information", and "income: a good life standard". The index includes four indicators in the dimensions of health, education, and income. HDI takes a value between 0 and 1. As the value of the index approaches to 0, human development is declining and is increasing as HDI approaches to 1 (UNDP, 1990).

The aim of this study and its differences from previous literature; both to introduce new computational approaches which make the HDI a better development measure, and to conduct a convergence analysis through the HDI results. Throughout the study, various suggestions have been put forward for strengthening the HDI's weaknesses. In doing so, HDI's three-dimensional approach has been adhered and new proposals have been developed in terms of HDI's calculation methodology. In this context, for selected countries and years new HDI values has been calculated and depending on these values convergence analysis has been conducted. It is targeted to show empirically that the new calculation method is a better measure of human development through the convergence tests.

The study consists of five sections. Introduction followed by second section which is dedicated to literature review. In the third section, which is actually the main body of this study, some alternatives are offered for HDI. In the fourth section, the new HDI values calculated according to the arguments put forward in the study and the convergence test for the selected years and countries were performed. In the last section evaluations has been made on making HDI a better development indicator, and some policy suggestions has been put forward.

The HDI brought many criticisms after it was first calculated and announced in 1990. McGillivray (1991) questioned the existence of the HDI by stating that a ranking made according to the HDI was similar to the order of income. On the other hand, Dasgupta and Weale (1992) stated that UNDP's HDI calculation is appropriate but political and personal freedoms should be addressed in the calculation. In order to avoid an insufficient measurement and evaluation problem for countries, Srinivasan (1994) considered that it will be more consistent to use GDP at purchasing power parity, instead of ordinary GDP per capita.

Mazumdar (2003) criticized the use of adjusted GDP under the income dimension in the 1993's HDI. Instead of the adjusted per capita GDP used by the UNDP, he took into account the uncorrected per capita GDP and compared with the original HDI for 174 countries. According to the results, the gap between rich and poor countries was higher than original HDI calculations. Hicks (1997) argued that by virtue of discounting of GDP by using adjusted GDP per capita in the income sub-index calculation, any increase in per capita income would decrease the impact on the HDI when a certain income threshold was exceeded.

Desai (1991) stated that it would not be appropriate to include the indicators under the dimensions of the HDI as equal weights and as a result, the indicators could substitute each other and thus may not reflect the correct value. Similarly, Noorbakhsh (1998) criticized the weighting method of dimensions and suggest that these weights should be re-derived. Gasper (2002) stated that the use of GDP with the same weight as other dimensions misled the countries in measuring or understanding human development. McGillivray (1991), Ravallion (1997) and Srinivasan (1994) criticized the inclusion of sub-indices in the same weights.

Kelley's (1991) criticism was also related to the arithmetic mean issue and he suggested to give more weight to the income dimension. The main point of the criticisms directed to the arithmetic mean in the literature is that the high-income countries' weaknesses in the other two dimensions are overshadowed by their high income. In Ranis (2004) and Ranis, Stewart and Ramirez (2000), it was found that there was a mutual and significant relationship between human development and economic growth. In this context, it has been concluded that public expenditure on health and education is one of the most important link between economic growth and human development. Besides criticisms, there are some studies in the literature that support the arithmetic mean approach. Tsague, Klasen and Zucchini (2011) have reached statistically supportive results for the equal weighting of the three components of the HDI.

Replacement of the arithmetic mean with the geometric mean in the 2010's HDI calculation have prevented the interchangeability of the three components. However, this new method has also been criticized. Thus, most people have not realized that the new calculation implicitly diminishes the weight on the life span in poor countries compared to the rich countries. For example, a poor country with a low life expectancy due to a worsening health system may improve its current HDI with a small economic growth rate. On the other hand, the new HDI's gains from additional education may seem unreasonably high. Ravallion (2012) argued that some such disturbing trade-offs could be avoided by using a different aggregation function for the HDI.

In the literature, alternative index proposals for HDI have also been proposed. In Sagar and Najam's (1998) joint study, a "Reformed HDI (RHDI)" with the same components as the HDI, using the multiplicative method instead of the arithmetic mean, and using the real values of GDP for the calculations, has been proposed. The results obtained with RHDI were extremely low compared to the original HDI. Paul (1996) has also derived a new index. "Modified HDI (MHDI)" was developed by adding infant survival rate as the fourth component to the HDI calculation method. MHDI has focused on the values of the lower-level countries, since it is difficult for countries with high HDI values to raise their HDIs further. With the MHDI, especially in developing countries, the results were very different from the original HDI. According to the study of Berenger and Chouchane (2006) for 170 countries, it was concluded that an index with broad participation would be established. According to Booysen (2002), popular indexes such as the HDI have contributed to the literature and various unified indexes have contributed to the development-based development indicators.

Segura and Moya (2009) in their joint work, developed a non-balancing perspective, "Non-Compensatory HDI (NCHDI)", which considers that the lack of any of the dimensions of the HDI cannot be compensated for by other successes. In accordance with this view, it is proposed to use of the minimum dimensions instead of the arithmetic mean. From this point of view, the HDI has been reconsidered and some calculations have been made for the last 5 years. In the new index, the ranking of the countries is differentiated and, above all, a new perspective on imbalances in the HDI has been introduced. Herrero, Martinez, and Villar (2010) compared the original HDI with two alternative indices. The first alternative is similar to the original but based on the calculation without taking logarithms. The second is a multiplicative version of the previous option. The results show that selection of multiplicative formula is important in two respects. On the one hand, the ranking of human development can vary considerably, especially for the middle developed countries. On the other hand, the addition process significantly affected the distribution of the indicators.

Lind (2010) developed an HDI to reflect training assessments and work efficiency. This new index, called "Calibrated Human Development Index (CDI)" has a simpler structure giving more weight to life expectancy and less weight to education. The findings of the study revealed that the CDI was highly correlated with life assessments from the World Values Survey. The country ranking in the CDI was very similar to the ranking in the HDI. In the study of Morse (2003), simplified HDI was recalculated for 114 countries between 1990 and 2001. First couple of calculations, made considering four scenarios, were related to health, other couple to income dimension. The minimum and maximum values of the health dimension were considered differently and the logarithm function was used differently for the income dimension. Compared to the original HDI, deviations occurred in the recalculated HDI. Noorbakhsh (1998) has developed an alternative index called "Modified HDI" by applying the principle of decreasing efficiency law to the education component and modifying the scaling method. He, firstly, formed three vectors of the standard components. Despite its healthier technical structure and use of decreasing efficiency rule for education, it produced almost similar ranking results with the HDI.

One of the most frequent criticisms for the HDI was that the index did not take into account inequality between countries. Grimm, Harttgen, Klasen and Misselhorn (2008) proposed a methodology that included three dimensions of HDI for the coefficients of income distribution. This methodology has enabled more

accurate comparison of poor countries and other countries' HDI. Empirical findings have shown that there are major inconsistencies particularly in the human development levels of African countries. In addition, it is determined that inequality in income is generally higher than inequality in education and life expectancy. Hicks (1997), according to the results of his study for Gini coefficients, which measure inequalities related to annual income, education level and life span for 20 developed countries; inequalities in the distribution of in-country income were found to be significant when taken into consideration in HDI calculation and an HDI including inequality coefficients called " Inequality Added Human Development Index (IAHDI)" was proposed. Ram (2009), for 30 years period between 1975-2004, by providing metrics of intercountry inequality for GDP per capita and HDI, have contributed to the current literature regarding differences between countries. It was concluded that the inequality in HDI decreased during the period and the rate of regression slowed down, especially in 1990, and the magnitude of inequality in HDI was very low. Klugman, Rodríguez and Choi (2011) proposed new amendments to the HDI formula and indicators. Innovations to expand the measurement of poverty and differences in human development have been demonstrated by some global and regional views. Martinez (2012), referring to the new HDI initiated by United Nations (UN) in 2010, in his study of inequality in the world analyzed according to successes in human development, the most known four inequality index Gini, Theil, Atkinson and Kolm were taken into account. It was concluded that the world was much more equal in 2010 than in 1980.

As beta and sigma convergence tests were conducted in our study, the contributions made to the literature in the context of convergence can be stated as follows. Sab and Smith (2002), using the health and education investments in 84 countries in the 1970-1990 period, as a result of their study on whether there is convergence between these countries, it was observed that there is a strong relationship between education investments and health and there is an unconditional convergence between schooling rates and life expectancy. Konya and Guisan (2008) tested convergence between countries in years from 1975 to 2005, in terms of human development in the world with traditional β (beta) and σ (sigma) convergence methods. Similar analyzes were made to countries entering the European Union (EU) before the 2004 enlargement, and all member countries of EU. According to the results, countries converged to each other and these countries managed to increase their HDI more than developed countries. According to the results of Mazumdar's (2002) study, aiming at measuring the standard of living in terms of HDI and performing convergence testing to countries for the period 1960-1995, almost all the tests have been ended with divergence. Neumayer (2003) carried out the convergence test for life time, infant health, literacy, telephone and television availability, which are the basic aspects of living standards during the 1960-1999 period and a strong convergence was observed. Konya (2011), in another study examined OECD and EU member states for human development in 1975-2005; countries tested whether low HDI countries are close to high HDI countries, poor OECD members are close to rich OECD members, and EU members entering the union between 2004 and 2007 are close to former EU members. The results showed that rise of the overall HDI was accompanied by convergence in all country groupings mentioned above.

Materials and Methods

Materials

In this study, we used yearly data for the period 1980-2015 for 95 countries in the world. We tried to include all countries into the sample according to data availability. In the calculation of Human Development Index values, there exists three dimension as education, health and income. For the education dimension, we used mean years of schooling and expected years of schooling and obtained the data from Human development reports of UNDP. For the health dimension, we used life expectancy at birth and obtained the data both from Human development reports of UNDP and world development indicators of World Bank. For the gini coefficients, obtained the data from both Human development reports of UNDP and world income inequality database of UNU-WIDER.

Methods

New Formula Proposals

Although UNDP successfully managed to defend some of the HDI features, it was seen that it is not a perfect benchmark for development given the criticism of the HDI due to lack of its structure and measurement techniques. In this study, we make various suggestions for the new formula in calculation of HDI. We try to make HDI a better criterion to measure the concept of development by using the acceptable and good-looking aspects of the original HDI and revealing the incorrect and amendable aspects of. Actually, we have four arguments in the approaches proposed as an alternative to the HDI. These are as follows:

- Calculating HDI without logarithmic transformation of the income dimension
- Instead of multiplying the values of health, education and income, collecting the square roots of these three components in order to reach HDI,
- Include the gini coefficient in HDI calculations
- Taking the arithmetic average of these three components by using the HDI formula in 1994 HDR again

According to UNDP, the additional income level does not contribute to people in higher income levels to increase their choices compared to people with low income levels, since people's wishes are limited in some cases and additional income is not so valuable after meeting some basic luxury needs. In theory, we are not against this idea. However, our suggestion is that this argument should be applied to other dimensions of the index. In addition, we can argue that UNDP does not take into account the level of income of countries sufficiently and makes the results of development calculations prone to convergence by exposing income components to decreasing returns, resulting in a decrease in income in the calculation of rich countries.

If the concern of countries and policy-makers is to provide at least the minimum conditions for each member of the society after reaching a sufficient (this of course depends on time, place and other things) quantity in undergraduate or graduate degree; giving primary and secondary school education to people without access to these level of education should be more important than increasing the number of university graduates. When we think of the life cycle component, our concern becomes clearer; if we do not think of extreme examples, everyone wants to survive for more than a year after 30s, rather than 60s. In some of the formula recommendations we have given in the previous section; combining these arguments, we have created an index that decreases each of them by applying a square root formula to each of the three components.

Theoretically, if there are two countries with the same level of success for the three components, the level of development of the country with inequality in income distribution should be considered lower than the others. From a methodological point of view, when inequality is high we can argue that the new formulas bring the HDI into a more coherent criterion by reducing the level of development by multiplying the success rate of the country with (1-Gini).

In all of the proposed formulas in this study, while the health and education dimension was calculated as in the original HDI, the income dimension differed from the original HDI in some recommendations and was not subjected to logarithmic transformation. On the other hand, the maximum and minimum values of all three dimensions are considered to be the same as the original HDI. The weights of these dimensions were chosen equally as in the original HDI. Because in statistical tests, many alternative weighting examples were found to be highly related to each other. UNDP has proven the reliability of the method of equal weighting with the Principal Component Analysis in the Human Development Report (1993). We will call

these formulas as Index 1, 2, 3, 4, 5, 6, 7, 8, and 9. We will be referring to the original HDI formula as Index 1 and number our suggestions in sequential order.

(1) $$Index\ 1 = \sqrt[3]{Health * Education * Income}$$

For the first formula proposal; we calculated Index 2 by considering all calculation same as in the original HDI, except logarithmic transformation of the sub-index of the income dimension. At the final step for calculating HDI value, we multiplied three dimensions as in the original approach and obtained the geometric mean of values. When calculating the Index 2, we included the income sub-index into the formula as follows.

(2) $$(Income\ nolog) = \frac{[(Real\ Value) - (Minimum\ Value)]}{[(Maximum\ Value) - (Minimum\ Value)]}$$

(3) $$Index\ 2 = \sqrt[3]{Health * Education * Income(nolog)}$$

While in original HDI three dimension values are multiplied to reach geometric mean, we have calculated the weighted average of square roots of three dimensions for our Index 3 calculation methodology proposal. As follows:

(4) $$Index\ 3 = \frac{\sqrt{\text{Health}} + \sqrt{\text{Education}} + \sqrt{\text{Income}}}{3}$$

Human Development Report in 1994, UNDP began to implement the HDI calculating arithmetic mean of three dimensions. UNDP (2010) abandoned this arithmetic calculation method used and moved on to geometric mean approach which is still used today. With the help of Index 4, re-using old version calculation methodology of UNDP (1994), we will be able to see how the change effected convergence results.

(5) $$Index\ 4 = \frac{Health + Education + Income}{3}$$

In another formula proposal, we multiplied each dimension by the value (1-Gini) and obtained the geometric mean of the dimensions as in the original HDI formula.

(6) $$Index\ 5 = \sqrt[3]{(Health * (1 - Gini)) * (Education * (1 - Gini)) * (Income * (1 - Gini))}$$

Next formula proposal Index 6 includes Gini coefficient as in Index 5, while only the income sub-index (as in Index 2) did not subject to logarithmic conversion and other two dimensions remained as original calculation.

(7) $$Index\ 6 = \sqrt[3]{(Health * (1 - Gini)) * (Education * (1 - Gini)) * (Income(nolog)) * (1 - Gini))}$$

In our Index 7 formula proposal, we have produced a new alternative by consolidating the formulas for Index 3 and Index 5.

(8) $$Index\ 7 = \frac{\sqrt{\text{Health} * (1 - Gini)} + \sqrt{\text{Education} * (1 - Gini)} + \sqrt{\text{Income} * (1 - Gini)}}{3}$$

By another formula, which we put forward by Index 8, in addition to the calculation methodology in Index 3 we calculated the income size without any logarithmic transformation as in the above formula and reached HDI value.

(9) $$Index\ 8 = \frac{\sqrt{\text{Health}} + \sqrt{\text{Education}} + \sqrt{\text{Income(nolog)}}}{3}$$

In our formula proposal 9, addition to the formula in Index 7 we changed the income dimension without taking the logarithm of the income sub-index. Gathering the income dimension (obtained in this way) and health-education sub-indicators (obtained with the original sub-index calculation methodology as in Index 7), we derived a new HDI value as Index 9.

(10) $$Index\ 9 = \frac{\sqrt{\text{Health}*(1-Gini)} + \sqrt{\text{Education}*(1-Gini)} + \sqrt{\text{Income(nolog)}*(1-Gini)}}{3}$$

In fact, we calculate four of our arguments in Index 2, Index 3, Index 4 and Index 5 respectively. Index 6, Index 7 and Index 8 are the calculation suggestions where three arguments are processed by pairs. Index 9 is the calculation of first three arguments at all.

3.2.2. Convergence Hypothesis

The convergence hypothesis was introduced in economics as a result of the neoclassical growth model introduced by Solow (1956). In general, convergence tests are performed by two approaches, known as β (beta) and σ (sigma) convergence. As required by principle of declining return of capital, developing countries with low capital stock will achieve a faster growth trend than the growth performance of developed countries due to the marginal efficiency of capital. Therefore, there will be a negative correlation between countries' initial income levels and growth rates. Thus, negative sign of Beta coefficient means convergence. This correlation is called Beta convergence in the literature. The positive sign of Beta coefficient indicates the existence of divergence (Islam, 2003).

We will adopt the following regression equation in calculating the β convergence for development level, which is used for income in the literature (Sala-i Martin, 1996):

(11) $$\left(\frac{1}{T}\right)\log\left(\frac{y_{i,t+T}}{y_{i,t}}\right) = \alpha + \beta\log\left(y_{i,t}\right) + \varepsilon_i$$

In equation 11: t is the beginning of term; t+T is the end of term; log ($y_{i,t}$) is logarithmic index value per person at the beginning of term; β coefficient is convergence rate ε_i is stochastic error term. Sigma (σ) convergence shows us how the income distribution has changed over time. In Sigma convergence, reduction in per capita income distribution by the time of progress between regions subject to comparison is a principle (Sala-i Martin, 1996). According to Sala-i Martin (1996) β convergence is a necessary condition for σ convergence, but not sufficient.

(12) $$(\sigma_{t+T} < \sigma_t)$$

As in β convergence, assuming t is the beginning of term and t+T is the end of term, in the equation mentioned above, σ will show us the standard deviation of the logarithm of the level of development per capita between countries at the instant of t.

Results

While conducting the convergence test, we considered 1980-2015, 1980-2009 and 2009-2015 years as three different periods in order to see the effect of global economic crisis on the human development levels. We tested 95 countries which we received full data about the dimensions of HDI. In addition to the calculation we have made on the basis of years; we compare the countries on the basis of income group (High Income,

Middle Income, Low Income), continent (Asia, Europe, Africa, America) and Gini coefficients (High Gini, Middle Gini, Low Gini).

Table1: Beta Convergence Results

	Index1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9
1980-2015	-0.0046 **	-0.0023 **	-0.0042 **	-0.0039 **	-0.0042 **	-0.0028 **	-0.0048 **	-0.0034 **	-0.0038 **
1980-2009	-0.0040 **	-0.0018 **	-0.0036 **	-0.0033 **	-0.0034 **	-0.0021 **	-0.0038 **	-0.0030 **	-0.0031 **
2009-2015	-0.0008 **	-0.0005 **	-0.0008 **	-0.0008 **	-0.0021 **	-0.0011 **	-0.0022 **	-0.0005 **	-0.0014 **
Africa	-0.0052 **	-0.0023	-0.0046 **	-0.0043 **	-0.0056 **	-0.0042	-0.0076 **	-0.0046 **	-0.0067 **
America	-0.0035 **	-0.0006	-0.0030	-0.0055 **	-0.0051	-0.0015	-0.0052	-0.0017	-0.0031
Asia	-0.0069 **	-0.0048 **	-0.0067 **	-0.0065 **	-0.0083 **	-0.0058 **	-0.0082 **	-0.0056 **	-0.0068 **
Europa	-0.0068 **	-0.0034 **	-0.0061 **	-0.0025 **	-0.0067 **	-0.0034	-0.0063 **	-0.0036 **	-0.0038
High Income	-0.0097 **	-0.0067 **	-0.0091 **	-0.0083 **	-0.0063 **	-0.0057 **	-0.0057 **	-0.0065 **	-0.0056 **
Middle Income	-0.0076 **	-0.0078 **	-0.0072 **	-0.0070 **	-0.0073 **	-0.0068 **	-0.0067 **	-0.0069 **	-0.0065 **
Low Income	-0.0075 **	-0.0059 **	-0.0074 **	-0.0074 **	-0.0073 **	-0.0080 **	-0.0100 **	-0.0077 **	-0.0098 **
Low Gini	-0.0040 **	-0.0011	-0.0033 **	-0.0029 **	-0.0056 **	-0.0019	-0.0054 **	-0.0023	-0.0036
Middle Gini	-0.0040 **	-0.0022 **	-0.0036 **	-0.0034 **	-0.0055 **	-0.0031 **	-0.0053 **	-0.0032 **	-0.0043 **
High Gini	-0.0055 **	-0.0033 **	-0.0052 **	-0.0050 **	-0.0065 **	-0.0041 **	-0.0063 **	-0.0043 **	-0.0052 **

* Indicates 5 percent level of significance and ** Indicates 1 percent level of significance

When we look at the period of 1980-2015 for all countries, the value of index 1 is 0.0046. In other words, Index 1 shows us that it takes 217 years (1 / 0.0046) to converge. Index 9, which includes every argument in this study, has a coefficient of 0.0038. The coefficient has decreased from 0.0046 to 0.0038. So the time needed for convergence rose to 263 years, longer than original formula, as we expected.

Other indices ended up with a similar situation. Looking at the overall values in the chart, there has been a drastic decline when moving from Index 1 to Index 2. This result shows that the income differences of countries, which is one of our main claims, are significantly large. By taking the logarithm of revenue, UNDP aims to narrow these differences further and reaches a result closer to the convergence. When we compare Index 2 and Index 1-3-4-5, the lowest coefficients are encountered in Index 2. This shows us how much the income varies between countries from 1980 to 2015.

When we look at Index 4, which is the HDI calculation methodology used by UNDP between 1994 and 2009, it is seen that the convergence rate has slowed down. As can be seen, while Index 1 converged in 217 years, the convergence rate of Index 4 slowed down to 256 years. Thus, changing the formula and shifting to the geometric average since 2010, the UNDP which uses the arithmetic average until that year, has

produced a result that serves the convergence. Therefore, if the UN continued with the arithmetic average without changing the formula, there would be less convergence than the current situation.

When we look at Index 5, which we included in the calculation of Gini coefficient, the value of all times decreased from 0.0046 in Index 1 to 0.0042 in Index 5 and convergence increased from 217 years to 238 years. The income distribution of countries is differentiated and distorted. Again, this is something that makes convergence difficult. The coefficient of Index 3 is also increased to 0.0042.

For the period of 1980-2009, the coefficient is 0.0040 in Index 1 decreased to 0.0018 in Index 2. When we look at the 2009-2015 period, while the coefficient of Index 1 is 0.0008, it decreases again in Index 2 which we do not use ln. The coefficient of Index 3 and Index 4 is the same with convergence calculated with the original formula. The unexpected result for this period is the calculation of the coefficient as 0.0021 in Index 5, where the Gini coefficient is used. In other words, there is more convergence than the one with original formula. About this conclusion, we can say that after the 2008 global crisis, the income distribution of countries may have converged. However, such a development is not very likely to occur in a very short period of six years.

The largest convergence in Index 1 by country is seen in Asian and European countries. As one can see that the worst situation is for America. We can interpret this as follows: North American and South American countries are very different. Therefore, we can say that the continent of America is less homogenous than other continents. There is no convergence in America. Or we can also comment on this result as: while North American countries developed rapidly within 35 years (between 1980 and 2015), South American countries which we included in the sample, made little progress. If there is progress in terms of development in Europe, all countries are progressing and developing more or less. If development in Asia is slow, it is slow for all countries. There is not much variation between African countries because they made no progress. It is possible to say that the situation in Africa is like in Asia.

In the income level results, the countries in the high-income group are more prone to converge. Looking at 1980, 2009 and 2015 separately, high-income countries were also in the high-income group in these three different years. We can conclude that there is not much differentiation between countries since we made the convergence according to the last income level (2015) and the income levels of these countries did not change much. When we look at the indexes 2-3-4-5, it is seen that the coefficients of middle and low income countries do not change much. We can say that the biggest change occurred in the high income group. Such an outcome shows how important income is. And it is one of the results that shows how much it is necessary to avoid the logarithm of income. When we look at Index 9, there is still a decrease in all values, only the coefficients of low-income countries have increased.

Grouping based on the Gini coefficient shows that, the countries in the high gini group got more close to each other compared to the low and medium gini countries in the index 1. High gini represents countries where income distribution is more unfair. We can say that the low and middle gini countries where the income distribution is fairer, there is not much change for these countries since they were already developed countries in 1980. When we look at Index 9, it's seen that there is not much change, although there is a decline in the way compared to Index 1. Here, we can conclude that the Gini coefficient is not as effective as the other factors such that avoiding logarithmic transformation of income and the formula with square root.

As we have already noted, β convergence is a prerequisite for σ convergence, but not sufficient. Therefore, to be able to talk about convergence, both conditions must be provided. In 1980 and 2015, the value of Index 1 in the whole sample decreased from 0.175 in 1980 to 0.110 in 2015. Such a decrease indicates an increase in convergence. Therefore, there has been a decrease about 40% in the value of Index 1 from 1980 to 2015. If we compare this value with any new index that we suggest, the results do not favour the convergence as much as index 1: 16% decline in index 2, 33% decline in index 3. In other words, the

decrease in these indexes is lower than the decrease in Index 1. The value of Index 9, which is our formula suggestion, was 0.144 in 1980 and regressed to 0.103 in 2015 with a decrease about 28%. Although there is a convergence in terms of sigma convergence results as in beta convergence results, we can see that there is less and slower convergence in the results obtained according to the new methodology we proposed. After all, when the sigma values are zero, it means the development index values of all countries are equal to each other. Therefore, the important point here is the rate at which the obtained values fall to zero.

Table 2: Sigma Convergence Results

	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9
Whole Sample 1980	0,175	0,297	0,081	0,152	0,228	0,343	0,108	0,119	0,144
Whole Sample 2009	0,119	0,262	0,058	0,114	0,17	0,303	0,084	0,092	0,116
Whole Sample 2015	0,11	0,25	0,054	0,105	0,143	0,276	0,07	0,088	0,103
Africa 1980	0,137	0,203	0,06	0,11	0,152	0,193	0,066	0,08	0,081
Africa 2015	0,081	0,181	0,039	0,075	0,084	0,169	0,041	0,053	0,053
America 1980	0,088	0,154	0,041	0,076	0,137	0,194	0,068	0,062	0,086
America 2015	0,064	0,156	0,031	0,062	0,105	0,193	0,052	0,055	0,074
Asia 1980	0,186	0,315	0,087	0,166	0,216	0,342	0,103	0,135	0,149
Asia 2015	0,08	0,204	0,039	0,077	0,061	0,18	0,03	0,077	0,066
Europa 1980	0,055	0,105	0,025	0,046	0,072	0,11	0,034	0,042	0,047
Europa 2015	0,027	0,079	0,013	0,027	0,043	0,09	0,022	0,032	0,039
High Income 1980	0,058	0,101	0,023	0,039	0,096	0,136	0,044	0,044	0,061
High Income 2015	0,019	0,06	0,009	0,018	0,055	0,081	0,027	0,027	0,038
Middle Income 1980	0,075	0,132	0,034	0,061	0,156	0,189	0,075	0,048	0,085
Middle Income 2015	0,037	0,07	0,018	0,035	0,087	0,109	0,043	0,028	0,05
Low Income 1980	0,135	0,176	0,059	0,109	0,141	0,168	0,062	0,079	0,078
Low Income 2015	0,061	0,121	0,029	0,056	0,081	0,132	0,04	0,035	0,044
High Gini 1980	0,221	0,356	0,101	0,189	0,278	0,407	0,129	0,148	0,173
High Gini 2015	0,114	0,257	0,055	0,108	0,12	0,263	0,059	0,092	0,096
Middle Gini 1980	0,172	0,305	0,079	0,148	0,207	0,336	0,097	0,121	0,138
Middle Gini 2015	0,112	0,255	0,054	0,104	0,113	0,256	0,055	0,088	0,088
Low Gini 1980	0,12	0,196	0,056	0,108	0,143	0,204	0,069	0,074	0,083
Low Gini 2015	0,09	0,201	0,044	0,087	0,097	0,202	0,048	0,069	0,071

Since it is a short period of 6 years between 2009 and 2015, we should see less declines when going from 2009 to 2015. All results in the chart confirm this expectation. On the basis of geographical continents, it is seen that Asian, European and African countries have faster convergence rates than American countries. If we recall the results of beta convergence, similar results were found in that analysis. Since the countries in the America are less homogeneous, there is no significant convergence in these countries. If there is a progress in Europe in terms of human development, all countries are progressing and developing in almost the same direction. In Asian countries, if human development is slow, it is slow for all countries. We can argue that there is not much difference between African countries because Africa made almost no progress.

When we look at the income level, the decrease in the sigma coefficient by about 70% means that the countries in the higher income group are more convergent. In Index 9, the convergence rate decreased by almost half to 38%. Overall, there has been a decline when moving from Index 1 to other indices, so this means that the convergence rate has decreased as expected. Similar results have been found here with Beta convergence.

In terms of Gini coefficient, the fastest convergence was seen in the countries in the high gini group again. The decline rate in Index 1 was approximately 49%. When we examine our final formula suggestion, Index 9, the rate of decline in the High-Gini group was 45% and the convergence rate decreased. The ratios in the other gini groups clearly show that the convergence rate in the index 9 is lower.

Conclusions

In our study, we suggested that the HDI has a room to be improved and made various suggestions to transform it into a better development criterion. While we used the same three dimensions of the HDI and used them exactly, we made some changes in the calculation method by suggesting some arguments. In addition to the original HDI, we made the calculation of the HDI of 95 countries with 9 indices for 1980, 2009 and 2015, based on these new computational approaches to the HDI. The reason for choosing 2009 as the middle year in the calculation is the desire to see the effects of 2008 global economic crisis on the development levels.

When the country-based data is analyzed in detail, we found that the income component, in terms of the values obtained according to the original HDI and new approach, is the main determinant of the difference in rankings. In the sub-index calculation of the original HDI approach of high-income countries, we have seen that this rule decreases countries' HDI values since logarithmic conversion of per capita income reduces the income differences between countries dramatically. We found that the health component approached the natural boundaries, and the income component could not be increased easily and therefore the most open area for development is education. Thus, a country should upgrade its education component in order to be successful in the HDI. We concluded that the significant increases in the educational component have a positive effect in HDI rankings of similar countries.

We have seen that the results of the beta and sigma convergence tests based on the values calculated with the new calculation approaches and the values calculated according to the original formula support our arguments. Considering UNDP's HDI calculation methodology, we have come to the conclusion that UN had results in favor of convergence by;

- Disregarding the differences in income component.
- Assigning the 1 as a power to the components rather than lower than 1.
- Using geometric mean instead of arithmetic mean.
- Not using the Gini coefficient.

Therefore, if the original HDI calculation method is revised as suggested according to the arguments in this paper, HDI will reflect human development in a better way and this approach will eliminate a significant failure of the original HDI that it shows more convergence rather than actually it is.

For the HDI to show real human development, the dimensions of the HDI need to be increased. Health, education and income dimensions as well as the variables required for a better life should be included in the HDI analysis. The indicators of the three components of the HDI should be expanded and new components such as environment, culture, technology, labor, discrimination should be considered in the calculations.

The distribution of income must also be taken into account in the HDI calculations. For example, since the income levels of oil exporting countries are high, HDI values are also high. But given the income distribution, income inequality in these countries will attract the index to a more accurate point. Moreover, in calculating HDI, UN actually measures health, education and income components numerically. So, quality is ignored. In the HDI calculation, UN needs to focus on the quality as well as the quantity; update and calculate HDI accordingly.

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