Towards the Unnecessity of Human Development Index: the Case of Sensitivity Analysis

Petr Mazouch [1] | *University of Economics, Prague, Czech Republic*
Kristýna Vltavská [2] | *University of Economics, Prague, Czech Republic*
Tomáš Staňek [3] | *University of Economics, Prague, Czech Republic*

Abstract

The Human development index is one of the most frequently used indicators of living conditions of population. We can find three dimensions in its structure – education, health and living standard. Since HDI represents a composite indicator combining three different indicators it is necessary to measure the sensitivity of each of its components. HDI is widely used to compare countries from any part of the world and therefore the variability of the indicators is high. The aim of this article is to show the dependency and mutual influence of individual imputed indicators to HDI. The construction of HDI and theoretical methods of sensitivity are also covered. Results show that the influence of individual inputs on the final HDI and its robustness differ among individual types of input and the strongest correlation of HDI occurs with the dimension of living standard. The influence of other indicators is affected by some other technical parameters of HDI construction.

Keywords

Human Development Index, Sensitivity Analysis, Gross National Income, Education, Health

JEL code

O15, C14

INTRODUCTION

Economic development and its relation to living conditions and living standard is very close. In the 1960s, opinions started to grow stronger criticising simplified views of economic development and the focus exclusively on the Gross Domestic Product. This only measures the value of the manufactured goods and rendered services, totally ignoring other aspects of human life (see Sixta, 2014; or Sixta and Vltavska, 2015; or Sixta and Fischer, 2014). However, a problem with the interpretation of macro- indicators from

[1] Faculty of Informatics and Statistics, Department of Economic Statistics, Nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. Corresponding author: e-mail: mazouchp@vse.cz.
[2] Faculty of Informatics and Statistics, Department of Economic Statistics, Nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic.
[3] Faculty of Informatics and Statistics, Nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic.

National accounts can be identified in many other ways (see Hindls and Hronová, 2015). The Human Development Index (hereafter HDI) was first introduced by the United Nations Development Programme (hereafter UNDP) in the Human Development Report in 1990 (UNDP, 1990). The purpose of the report was to draw attention towards human development. The index and its construction aims at adequation of various phenomena by means of indicators that are subsequently aggregated into one figure (in essence, it actually comprises a composite indicator – Hudrlíková, 2013).

The HDI includes three basic dimensions with an equal importance for the calculation – an ability to lead a long and healthy life; an ability to get educated and gain knowledge; an ability to live a life with a certain minimal living standard. Although the specific style of the calculation of the indicator differs throughout the history of HDI, these basic dimensions do not change (Syrovátka, 2008, p. 13).

As it is important to measure the progress of society many authors discussed the possibility to estimate the level and compare countries as Vopravil, 2009 did or to venture beyond the GPD in order to measure the real true wealth and welfare of a nation (Křovák, Ritchelová, 2008; or Dubská, Drápal, 2010). Some studies also analyzed the types of indicator-related initiatives run by respective bodies (Hák, Janoušková, 2013).

The article aims – by means of suitable methods – to describe the dependency and the influence among individual HDI input indicators, and among these inputs and the index itself. Sensitivity analysis is applied in order to achieve this goal, including its various methods estimating the influence of individual inputs on the final HDI and to determine – in combination with the knowledge of HDI construction – whether this calculation is sufficiently robust. Results and conclusion were presented by Stanek (2015).

1 METHODOLOGY

1.1 HDI construction

To enable the construction of a composite indicator that includes several different indicators with various ranges of values, the following steps are taken: two dimensions (health and living standard) are measured by means of one indicator while the education factor by means of two. Each indicator is measured in a different unit and reaches completely different values and therefore the data are standardised. To this end, UNDP transforms the values to a range between zero and one, with zero being the worst and one the best possible score. This standardisation uses formula 1 (UNDP, 2014b):

$$\textit{component index} = \frac{\textit{the real value} - \textit{minimal value}}{\textit{maximal value} - \textit{minimal value}} \,. \tag{1}$$

Hereby, component indices are created – the Index of Life Expectancy at Birth, the Education Index and the Index of Gross National Product – which are subsequently averaged via geometrical mean.

The extreme values for the Index of Life Expectancy at Birth are 20 and 85 years. All countries fall within this interval and none has an index lower than zero or higher than one. The highest values in the report from 2014 are reached in Japan with 83.6 years of life expectancy at birth and the value of the component index of 0.987. On the other hand, Sierra Leone with the life expectancy at birth of 45.6 years and the value of the component Index of Life Expectancy at Birth of 0.393 remains last in the ranking (UNDP, 2014a).

The Education Index consists of two indicators – the average length of schooling and expected length of schooling. Both indicators lack the minimum level (theoretically, it is zero and zero is also applied as minimum in the calculation of the index) and the maximum reaches 15 and 18 years, respectively (UNDP, 2014b). The lowest values of the average length of schooling were registered in Burkina Faso with 1.3 years and the highest were recorded in Germany and the USA with 12.9 years. Concerning the expected length of schooling, the countries at the opposing ends of the ranking are Eritrea with 4.1 years and Australia with 19.9 years (UNDP, 2014a). The arithmetic mean of the average and expected length of schooling represents the Education Index.

The Index of the Gross National Product (GNP) has to undergo another adjustment, unlike the other indicators. Large differences among countries call for a more sophisticated approach to GNP than to the other indicators. If the maximal value was set as GNP value of the leading country or an exact limit was set – which would have to be even higher or at least very close to the leading country – the differences would open up much more than in the other dimensions of HDI. Half of the countries would achieve less than 50% of the maximum value (Syrovátka, 2008). UNDP solves this problem by calculating the natural logarithm of GNP values. Therefore, the same nominal increase in developed countries causes a smaller increase of the index (UNDP, 2010). 100 USD of GNP in the purchasing power parity sets the minimal value, while the maximal value reaches 75 000 USD (UNDP, 2014b). The worst country in this respect in the report from 2014 is the Democratic Republic of Congo with the GNP of 444 USD and the index value of 0.225. The highest ranking country was Qatar, reaching 119 029 USD of the GNP (UNDP, 2014a). Thus, Qatar exceeded the limit set for the maximal value and its component index equals one. Two more countries, namely Lichtenstein and Kuwait, exceeded the limit. Formula 2 represents the calculation of the Gross National Product index:

$$GNP\ Index = \frac{ln(GNP_{country}) - ln(100)}{ln(75\ 000) - ln(100)}. \tag{2}$$

The total index is then calculated as a geometric mean of component indices of its individual dimensions. (UNDP, 2010).

Although the result of HDI is a measurable and a continuous quantity, countries are typically divided according to the following table.

Table 1 Dividing countries into groups according to HDI

Group	HDI limit
Very high human development	> 0.800
High human development	0.700 – 0.800
Medium human development	0.550 – 0.700
Low human development	< 0.550

Source: UNDP, 2014b

1.2 Sensitivity analysis

Sensitivity analysis works with already finalized models and its main target is determining the importance of individual inputs or the impact of interactions among more variables on the final output (Saltelli et al., 2008). Sensitivity analysis uses a whole range of approaches for assessment (for more, see Saltelli et al., 2008). This article uses the following ones: a scatter plot, methods based on variance, a one-at-a-time method.

1.2.1 Scatter Plot

A scatter plot (i.e. a diagram of correlations) works with a graphic demonstration of the effects of different variables. One axis represents a certain variable and the other the final output (Saltelli et al., 2008). Although other kinds of input naturally participate in the output as well, with a large number of occurrences, one can draw conclusions from the graph which creates ground for further work. Working with the given data offers another advantage. If we only know the model, on the other hand, we can randomly generate values of inputs and outputs and present them afterwards (Saltelli et al., 2008).

In this case, the basic tool of the analysis is a traditional graphic representation although other methods of scatter plots may be used as well. The input variable can be divided into arbitrarily chosen parts and subsequently the conditional average of input for each category is calculated. Even this leads to the same conclusion as the analysis of the traditional scatter plot. The method of conditional average looks more transparent, but it can hide some important information. For example, it totally neglects the spread of the points in individual categories and thus the average may be influenced by several close values or the spread may differ dramatically among the various categories.

1.2.2 Methods based on variance

Methods based on variance aim to decompose variance of the output and assign it relatively to various inputs or input groups (Saltelli et al., 2008). Such effort may result in a simplified statement that the final variance of the output depends in 20% on input A and in 60% on input B and in 20% on the combination of both inputs. Afterwards, these values may be interpreted as the impact of the input on the final output.

Deriving formulas are observed by Sobol's theory of variance decomposition (Sobol, 1993) which assumes independency and even distribution of input variables. Sobol (1993) proves that the overall variance may be decomposed in the following way:

$$Var(Y) = \sum_{i=1}^{d} V_i + \sum_{i<j}^{d} V_{ij} + \ldots + V_{12\ldots d}\,, \tag{3}$$

where i and j represent individual inputs, d is the number of inputs and

$$V_i = Var_{X_i}(E_{X_{\sim i}}(Y|X_i),$$

$$V_{ij} = Var_{X_{ij}}(E_{X_{\sim ij}}(Y|X_{ij}).$$

Mark $\sim X_i$ stands for a combination of all input variables except X_i. V_i marks the variance of conditional averages for the X_i categories limitary in size as presented in the part of the scatter spot analysis. The overall Sobol's (1993) decomposition does not include only conditional variance of individual inputs but also all their conceivable combinations. In total, it consists of 2^d–1 components.

This decomposition leads to two statistics used for the sensitivity analysis. One is the **first-order index** (Saltelli et al., 2008):

$$S_i = \frac{V_i}{V(Y)}\,, \tag{4}$$

which determines the effect of the variance of an input on the overall variance of output. Indices may be calculated even by means of the combination of the S_{ij} input. The total of all these indices are – as a direct consequence of Sobol's decomposition – 1 (Sobol, 1993). According to another interpretation, the first-order index indicates how large a drop in variance would occur if input i gets fixed.

The other statistic is the **total-effect index** (Saltelli et al., 2008). For the first input, this may be calculated by means of formula 5:

$$S_{T_1} = S_1 + S_{12} + S_{13} + S_{123} + \ldots + S_{1d}\,, \tag{5}$$

where S_{T_1} is the total variance of inputs caused either directly by the first input or by the interactions of the first input and other inputs. S_1 is a first-order index and the other addends consist of first-order indices as well, i.e. indices of various interactions of inputs where the first input occurs.

The total-effect index adds up all first-order indices with the occurrence of the given input, i.e. all possible interactions that include the given input. The sum of these indices for all inputs is higher than 1 because interactions among inputs are counted in with all included inputs. Only in the case of a strictly additive model, when there are no interactions among inputs, the total-effect indices equal those of the first-order and their total reaches one again (Saltelli et al., 2008).

The calculation of these indices mostly employs the Monte Carlo method. This comprises the estimation of individual effects based on multiple sightings or rather based on a high number of simulations of the model with random inputs (Fabian, Kluiber, 1998). Due to the complexity and demands in terms of the computing power, various more sophisticated algorithms are used as well. They simplify the calculation, e.g. by neglecting first-order indices with many interactions which practice proves less important. Two examples of these algorithms are HDMR (High-Dimensional Model Representations) and FAST (Fourier Amplitude Sensitivity Test) (Saltelli et al., 2008).

Methods based on variance are very popular, especially due to independence of the model when it is unnecessary to limit or even know the basic relationships among inputs and outputs (linear or not, etc.). Another advantage is the emphasis on interactions among variables which are easy to interpret when using methods based on variance. More complicated models often show inadequate demands on the computing power in order to achieve a robust result (Saltelli et al., 2008).

1.2.3 Monte Carlo

Monte Carlo is a class of algorithms that use multiple repetition of random processes in order to reach numerical results. The beginnings of this method date back to the 1940s to the Los Alamos laboratories with Stanislav Ulam and Nicholas Metropolis being among the first scientists using and publishing this method (Metropolis, Ulam, 1949). The quality of results with the Monte Carlo Method is influenced by the following factors (Fabian, Kluiber, 1998, p. 152):

- The quality of the random number generator;
- The selection of a rational algorithm for the calculation;
- Monitoring of the precision of the acquired result.

For our purpose, the Monte Carlo Method was employed to estimate the above mentioned statistics used in methods based on variance. The given approach corresponds to Saltelli et al. (2008).

1.2.4 One-at-a-time Method

The One-at-a-time Method represents a basic and intuitive approach that only changes one variable among multiple input variables and monitors the result in the final output. Although this is a simple procedure – if used and interpreted correctly – it may – as other simple methods of sensitivity analysis – bring highly relevant information (Panell, 1997).

The approach used in such analysis is simple and understandable and any change in the output is attributed to the change in the specific input. The calculation is not complicated and the interpretation is easy as well. A problem which commonly occurs with this method is the difference in inputs. They tend to have various ranges and probability division and therefore it is difficult to compare different changes throughout variables. Besides, it requires knowledge of the model and it is not possible to analyse mere data. Also, the possibility of interactions among variables is neglected (Saltelli et al., 2008).

On the other hand, analysing which dimensions represent the thinnest change and what dimensions – if improved – bring the highest effect on HDI value might comprise an interesting use of the One-at-a-time method. To this end, each individual category in each country gained one hundredth of the defined interval in the given dimension. After recalculating the results, the change showing the highest effect of the three possibilities was identified.

The One-at-a-time method can be used for another purpose. It does not assess the importance of inputs with regard to the value of the output but examines the robustness of the results depending on wrong data and other inaccuracies. Other researchers (Wolff et al., 2011) have already estimated standard deviations of HDI values for various countries. Provided that we accept the notion that the errancy (based on errors in measuring compared during data revision) remained approximately the same, we can measure how these inaccuracies may reflect in the ranking of individual countries based on new data. An interval of reliability is constructed for each country, arising from the assumption of normal distribution. Subsequently, the change of the position of the country in the ranking is determined for a case when the extremes of the interval were used instead of its mean. This procedure repeats with each state and the resulting number to work with represents the average change of places in the ranking.

1.3 Data

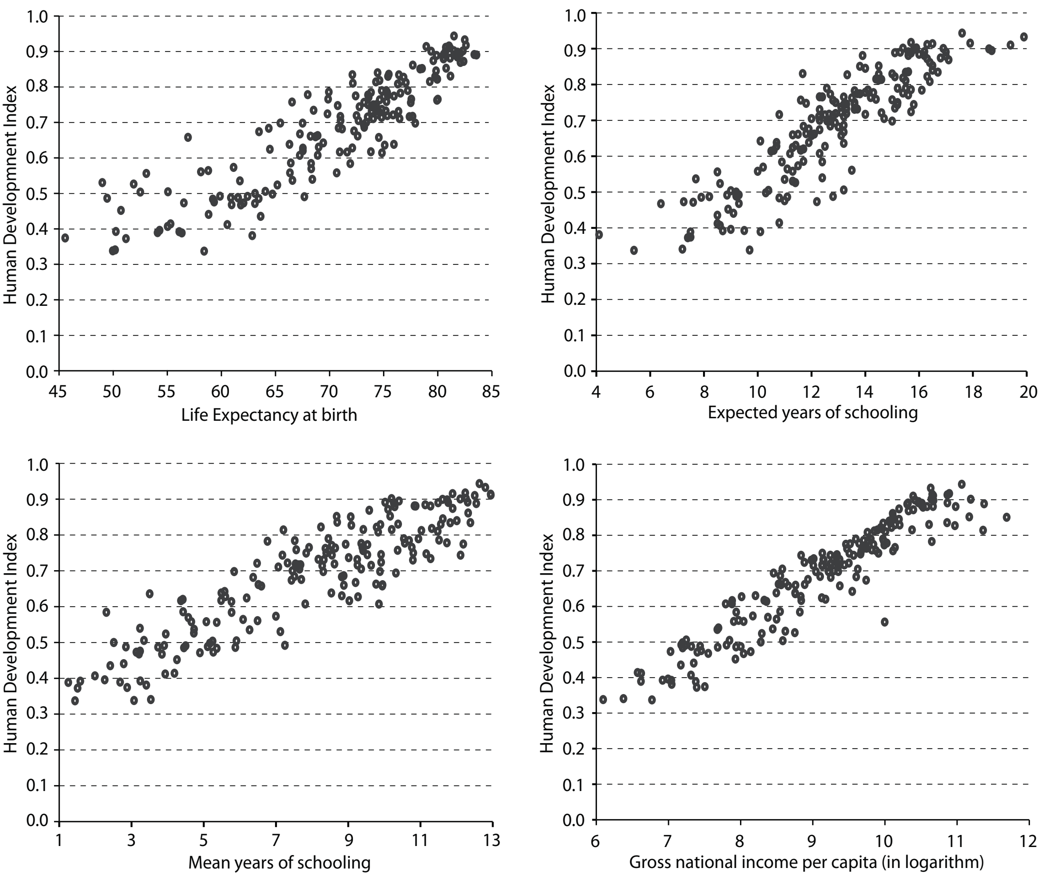
For calculations, the data published by UNDP and employed for the calculation of HDI index in the 2014 report (UNDP, 2014a) were used. The data offer complete sets of all input components for 187 countries and we eliminated countries with incomplete information. The data in the report cover the years 2012 and 2013 – life expectancy and GNP per capita are from 2013 and the data for the dimension of education are from 2012.

2 RESULTS

2.1 Scatter Plot

A simple scatter plot is a basic method of sensitivity analysis where the *x*-axis represents the input variable and the y-axis represents the output (dependent) variable.

Figure 1 Scatter plots for various inputs



Source: Authors' computation

With all variables, we can track a clear linear coherence with the output. In this particular case, we are more interested in the power of dependency which seems to be strongest with the logarithmed GNP values. This causes that the progress in GNP is more important for countries with lower level of this indicator and the progress of GNP could hide poor quality in the other areas.

2.2 Methods based on variance

The first-order index may be interpreted as “by how much the variance of output could drop if the appropriate input was fixed” (Saltelli et al., 2008). It quantifies the direct effect of a variable without examining interactions with other inputs. First-order indices with the use of the described approximation are shown in Table 2.

Table 2 First-order indices

Input	S_i
Life expectancy	0.2790
Average length of education	0.0512
Expected length of education	0.0513
Gross National Product	0.5540

Source: Authors' results

With the declared equality of all dimensions, the results of the first-order indices seem discordant. The cause of this lies in an even distribution of inputs and the method of HDI calculation – especially the geometrical mean. First, average and expected length of education co-build one dimension of three. Both indices are equal in these variables, which corresponds to the same amount of importance within the dimension. Even after adding them up though, they do not amount to the same importance as the other two dimensions. This is attributed to the nature of the calculation of the education dimension which averages two values. With the condition of independence and equal distribution, this results in the values being closer to the mean of the interval with a smaller spread than when using one variable as in the case of the health dimension. This better stability in combination with the geometric mean, which reflects much more the remote and digressional values, leads to lower importance for the final variance of the model.

Life expectancy is the simplest case and therefore the health dimension directly causes almost a third of the spread of the output, just as one would expect. Anyway, even this value is noticeably lower than a precise third. This arises in the misbalance in the third dimension, i.e. the standard of living which requires the values to be logarithmed.

Another important aspect of the model is the sum of all first-order indices that amounts to 0.9354. For a completely additive model, i.e. without any interactions and compound effects of variables, the sum equals 1. In comparison, due to an approach being based on the geometrical mean HDI is not fully additive and is influenced by interactions among variables.

Another statistic – the total-effect index – quantifies the overall impact of the given input with all higher orders of various interactions. These indices are either identical with first-order indices or higher and their sum does not have to equal 1 or less because the interactions are added to all included inputs. Therefore, they appear multiple times frequently in the sum, according to the order of the interaction. The results of the indices for our model are shown in Table 3.

Table 3 Total-effect indices and the difference from first-order indices

Input	S_{Ti}	$S_{Ti} - S_i$
Life expectancy	0.3299	0.0509
Average length of education	0.0692	0.0180
Expected length of education	0.0691	0.0179
Gross National Product	0.6057	0.0517

Source: Authors' results

The differences between the total-effect and first-order indices are significant. The discrepancy between these statistics indicates the amount of inclusion in interactions among inputs influencing the output. Clearly, neither expected nor average length of education gained more importance in this respect as the education dimension is more stable with the average of 0.5. Therefore, interactions are not so significant due to geometrical mean. The effect with the other two dimensions is balanced. The sum of the total-effect indices is 1.0739.

2.3 Identification of the relatively weakest dimensions for various countries

Table 4 shows overall numbers of countries which achieve the highest improvement in the given dimension with the One-at-a-time method.

Table 4 Numbers of countries with a relatively weakest dimension

Dimensions	Number of countries
Health	11
Education	88
Living standard	88

Source: Authors' results

Health is the dimension with the lowest number of countries for which this area represents the largest space for improvement. The other two dimensions are equal. This means that the level of life expectancy of a new-born child is a critical indicator for only a few countries whose HDI indicator is drawn lower in consequence.

The list of those countries proves interesting. This little group – ranking digressively in terms of HDI – consists of Australia, New Zealand, Ireland, Estonia, Lithuania, Latvia, Belorussia, Russian Federation, Kazakhstan and the Republic of South Africa. The countries mentioned in the first four places are among the top places in HDI. They surpass other European countries which are at the top along with them especially in terms of the expected length of education which is longer approximately by three years compared to similar countries. Therefore, it does not make too much sense to further extend the length of education. Also, nominal increase of GNP in such developed countries is of little significance. Life expectancy itself is not strikingly lower than in comparable countries.

Another significant unit was created among post-Soviet countries where this occurrence obviously arises from large differences in the life expectancy compared to similar countries. This discrepancy amounts to approximately five years in comparison to countries with a similar HDI. This group encompasses the most developed countries of the Soviet bloc. However, other countries of the bloc (Ukraine, Azerbaijan) record a worse life expectancy as well, with Azerbaijan showing comparably worse education and Ukraine trailing in terms of GNP. This difference is not so apparent with other Caucasus post-Soviet countries (Georgia, Armenia) but these countries are rather low in HDI ranking. The logical conclusion behind HDI and One-at-a-time method calculation indicated prevailing lower life expectancy in post-soviet countries in contrast with their human development. The last country is the Republic of South Africa which demonstrates dramatically low life expectancy compared to its education and especially income. The difference in life expectancy from the Philippines, a country one position higher in the ranking, amounts to 12 years.

The numbers of countries with the highest improvement potential in the given category are divided according to Table 1 into four categories of development.

Table 5 Division of countries according to the relatively weakest dimension into categories of human development

	Very high human development	High human development	Medium human development	Low human development
Health	7	3	1	0
Education	42	37	9	0
Living standard	0	13	32	43

Source: Authors' results

This clearly illustrates the gradual change in the importance of education and living standard. While the most developed countries share the most effective way of improving the index in education, on the other hand, in the countries with lower level of human development this relationship between education and living standard is changing and for countries from the lowest group the most important is a growing GNP.

Although the most developed countries demonstrate the highest values even in education this reflects the relativity of the numbers when an increase in GNP does not gain any significance due to logarithming and neither does prolonging the life expectancy. Only such countries comprise an exception in the first category that have a considerably lower life expectancy (post-communist countries) or countries that exceeded the maximal length of expected education and further extension would prove useless. In contrast, developing countries can achieve a relatively high Health Index because even in really dire conditions such figure exceeds the set minimum of 20 years. Moreover, in the education dimension these countries move upwards especially due to the expected length of education. Therefore, their largest relative loss is GNP where very low values result in a difference between the linear increase in GNP and its real logarithmed impact that is not so high.

The initial notion of equality of all dimensions within HDI may be disturbed if we realize that relatively identical changes in various components bear different impacts for a very diverse number of countries according to a dimension. In other words, a change in life expectancy is for most countries less important than changes in other dimensions and thus it loses importance. A potential solution would be moving the minimum limit above 20 years because in the 2014 report even the lowest country, Sierra Leone, has the life expectancy of 45.6 years (UNDP, 2014a).

2.4 The impact of error on the result

Table 6 shows the influence of a potential error in data on the ranking of countries according to human development. A change in the ranking in this respect shows how many countries with an unchanged HDI ended up within the reliability interval of the given country. The average change of ranking describes the average of this count among all countries or among categories.

Table 6 Average change of ranking based on the correction of data according to the human development category

Category of countries	Average change of ranking
All	11.1
Very high human development	6.2
High human development	13.7
Medium human development	11.9
Low human development	12.2

Source: Authors' results

Although the results need to be taken with some reserve, changes in ranking due to errors in data which are discovered in a follow-up revision clearly occur quite frequently. In comparison with the previous set, these numbers grew especially due to a larger amount of countries examined. These countries create a denser net of HDI values and changes in such ranking are nominally higher. This clearly illustrates the danger of simple comparison in time. Newly entering countries or countries which have been excluded may influence the results significantly. The higher the number of the countries, the stronger influence a similar error bears. Countries with very high human development tend to face much lower risk of error in ranking. This is due to more reliable data and thus a lower standard deviation. For comparison, standard deviations in retrograde according to categories of development were: 0.013, 0.023, 0.032 and 0.029.

3 DISCUSSION

HDI has been subject to harsh criticism for various reasons since its very beginning. This criticism is understandable because the index is closely watched, often presented and it tries to quantify a very wide and to a large extent hazy concept of human development in an exact manner.

T.N. Srinavasan (1994) describes HDI in his work as "conceptually weak and empirically unsolid, containing a lot of problematic issues – incomparability in time and space, errors of measurement and bias. Sensible conclusions of the process of human development, output or impact of various political decisions can be hardly made on the basis of the variance of the HDI" (Srinavasan, 1994). Although this text was written shortly after the beginning of the index calculations, it still proves topical. Even nowadays, UNDP has to face criticism of the whole concept of human development, its division into these three specific dimensions with equal weights, the individual indicators, the data gathering, the calculation and many more issues. UNDP itself has published a document summarizing the criticism (Kovacevic, 2010).

Probably the most serious criticism aims at the whole ***concept*** of HDI. For example, the before-mentioned economist Srinavasan called it redundant and literally "reinventing the wheel" in his article (Srinavasan, 1994). HDI as such brings no new information; it only reacts to data which are already known and relatively well monitored. HDI shifts the attention from these fundamental numbers and although it seems comprehensible for the lay audience it does not represent any specific value. On the contrary, HDI shields specific problems according to this approach. Another opinion which may be included in refusing the whole concept of HDI claims that human development defies any kind of quantification in principle (Negussie, 2015).

Defining the ***dimensions*** and their weights are also a frequently criticised area. The index totally lacks for example any information on ecology or on political and human liberties which play an absolutely crucial role in assessing human opportunities which actually form the basis of the theory of the whole index (UNDP, 1990). The equality of the constituents represents a further, frequently criticised fact.

The introduction of the geometrical mean partially solved this problem which prevented the absolute substitutability. Moreover, via the geometrical mean the index gained a higher informative value as it does not hide the way in which specific countries achieved their respective values of the index (UNDP, 2010).

The choice of the ***specific indicators*** presents another disputable factor. Besides the difficulties with expressing individual elements of human development with a definite number, statisticians also have to estimate the correctness and availability of data. Moreover, the whole index must be very simple and comprehensible. The measurement of the living standard as GNP represents the least of the problems from this point of view. Health, expressed as life expectancy, also constitutes a rather understandable figure although it disregards the quality of life or health in general. We deem the third dimension the most vulnerable to criticism though. The level of the system of education is characterised by the average and expected length of education which actually describe the real erudition of the population to a rather limited extent. For example, some states in Germany decided to shorten the length of the study at their grammar schools (Gymnasiums) by 1 year to 8 years, i.e. 13 years in total compared to previous 14 (Economist, 2014). However, the federal states in Germany with a lower length of education achieved better academic results in the long run (Economist, 2014). No HDI indicator should be debatable in the sense that it might prove more beneficial to a country to decrease it. Germany found itself under no pressure – economic or any other; the country only wanted to straighten the length of its education among individual states. Thus, Germany actually decided to lower its HDI. Anyway, an incessant increase in qualification requirements and studies at schools which bring no real deepening of knowledge or skills is a problem discussed a lot in the Czech Republic. For instance, the former minister of Ministry of Education, Sports and Youth was trying to increase the number of apprentices at vocational schools at the expense of the number of students of grammar schools (EDUin, 2015). This, in effect, would mean shorter length of education. Hence, this indicator seems problematic. Although rich and successful countries can afford a longer period of education – which without a doubt reflects the level of their development – the longest period of education is not an indisputable aim for every society. On the other hand, this is true about the other dimensions – life expectancy and GNP.

Another problem frequently debated is comparing development throughout the world although given countries are on a totally different level of development. The criticism aims at the question whether it is even possible to compare e.g. Finland and Nigeria by means of one composite indicator and whether such comparison brings any relevant information at all (Syrovátka, 2008). This problem already played an obvious role in the calculation of HDI itself. The dimension of education used to include even literacy. However, this statistic proves dead for current developed countries as most of them achieve 99%. Although developing countries undoubtedly consider the proportion of people able to read and write very important, for example almost all European countries have already solved this issue. Therefore, this category brings no relevant information and cannot describe differences and variance among such states. This particular display of the problem was solved by changing the indicator. Nevertheless, the underlying essence of the problem is still present. A potential solution is simple – to employ various indicators in various groups of development, for example as suggested by Anand and Sen (1994).

3.1 What the results of sensitivity analysis showed

In sensitivity analysis, it is necessary to trivially state the importance of all inputs again, i.e. the direct importance and further the importance caused by the dependency of the remaining indicators which affect the output. Due to this, appropriate application and interpretation of all acquired results proves difficult since the theory of sensitivity analysis assumes inputs to be mainly uncorrelated. A failure to fulfil this condition leads to rather unexpected results with the use of variance methods, with an increased impact of the dimension of living standard – i.e. GNP – on the final HDI output. Meanwhile, the apparent non-additivity of the model comes up as the source of this problem. This finding directly negates the base of the calculation of the index where all dimensions are supposed to be equal. However, this problem does not practically occur with real data and we acquired no significant drop in average values of component indices of dimensions. On the contrary, the values tend to be rather even-tempered. From a purely theoretical point of view though, this model does not weigh the three components equally.

It is an interesting point to find out the most important dimensions for various countries, i.e. dimensions that – with the relatively same increase of an indicator – push the given country's HDI index the furthest. Such analysis brings clear results and interpretations. The lowest countries can profit the most (in terms of the value of the index) on improving the living standard while the highest countries from promoting education. A small specific group of countries with a maximum length of education and some post-soviet countries have their weakest point in the health dimension. The results may be looked upon from several points of view. Firstly, it is definitely positive that two dimensions are almost equal in terms of the number of countries. On the other hand, the third dimension – health – is obviously weaker, which denies the precondition of equality among the components. The health dimension is on average higher in total (although we are not claiming the difference to be dramatic) and the number of countries with the most effective impact in this dimension proved the smallest. In general, this is mostly caused by the fact that even with a really low level of development life expectancy is still much higher than the bottom limit of 20 years. Hence, even developing countries with a minimum GNP and practically non-existing education achieve a relatively strong health index. Therefore, we believe that it would prove beneficial to increase the minimum limit in the health index in order to move more countries into the group with the most effective impacts in the health dimension. The numbers of countries within the groups would even out and the component indices would be equal. This would lead to fulfilling the precondition of the equality of dimensions. There is no reason to assume that the 20-year mark is really the minimum limit when even the lowest countries achieve results far above.

The division of the importance of various dimensions for countries on different levels of development offers another possible field for interpretation. On one hand, the most important factor to improve for countries which are only little developed represents the GNP. This leads to an uplift of both education and health. On the other hand, developed countries have sufficient means and it is only necessary to redirect them in the right course. This interpretation may be too generalizing, simplifying and based on the notions of HDI authors who imprinted the index with exactly this calculation. Nevertheless, it may bring interesting reflections.

Finally, one should take into account the fact that errors in the data set used may alter the results of individual countries significantly. This does not comprise a larger problem for developed countries where data are rarely incoherent. On the other hand, the differences in the HDI among countries on medium and poor level of development proved small due to a high number of countries included. Among these countries, data far from reality may be used and thus grossly distort the ranking. The results should be analysed carefully and attention should be paid to gaining more reliable data and assessing the risks and advantages of involving a maximal number of countries.

CONCLUSION

HDI in itself constitutes a rather debatable and often criticised phenomenon not only for the reasons stated in the article. It is appropriate to question the need for such a problematic index that offers only a little more informational value than GDP or GNP whose dominance the authors tried to escape. The importance of the index does not lie in its specific values and results but in its existence which incessantly fuels the debate about the real life situation of people in various countries. If one looks for primary information on a given country, one will often find HDI among the fundamental data, which shows its importance and the success of its authors. The broadest public needs a slightly simplifying view of this field and a basic figure, serving as a starting point – which is exactly what the index offers. Due to the index, UNDP brings the attention of a broad audience towards its annual reports where various problems of human development in more depth are discussed and provide data available to the public. One cannot claim what strongest needs the most poorly developed countries have but the most developed countries show that the level of wealth indicated by GNP proves sufficient for decent life and all relevant and necessary human needs. Afterwards, the attention of the society should focus to another area with the aim to improve the life of all citizens – no matter how this general aim is defined. Anyway, discussion may prove crucial in bringing us further in this rather subjective field.

Aim of the paper was to describe the dependency and the influence among individual HDI input indicators, and among these inputs and the index itself but the analysis is influenced also by fact that HDI is composite indicator and as can be found in Hudrlikova (2013) composite indicators by its nature are very susceptible to many factors from the very beginning of their construction.

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