Ekonomi-tek Volume / Cilt: 5 No: 3 September / Eylül 2016, 1-20

Calculation of the Human Development Index For Northern Cyprus Using Economic Measurements From The Post-Conflict Period

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Abstract

Development has always been treated as an economic phenomenon and linked to economic growth. Amartya Sen's "capabilities" approach (Sen, 1985) introduced the concept of "human development" as progress towards greater societal well-being. The Human Development Index, the HDI, is a summary measure of average achievement in key dimensions of life: a long and healthy lifespan, being knowledgeable, and having a decent standard of living. The HDI relies on various proxies to demonstrate key capabilities: i.e., access to health, education, and goods. The HDI is the geometric mean of these three-dimensional indices.

The HDI has been calculated by the United Nations Development Program (UNDP) since 1990 and serves as a measure of human well-being; it ranks countries on a scale between zero and one. Northern Cyprus (herein referred to as the Turkish Republic of Northern Cyprus, or the TRNC) has been ignored in such calculations, although the HDI has been applied to similar territories. Thus, the purpose of this paper is to calculate the HDI for the TRNC using observed series during its post-conflict era. At the same time, we discuss the Granger Causality of HDI in Northern Cyprus and Turkey. The finding indicates that the HDI of the TRNC has the ability to predict the HDI of Turkey, while its reverse is not true. The paper also examines the relationships between HDI and GNI according to separate Fixed-Effect Panel Models and Seemingly Unrelated Regression (SUR) Equations of HDI and GNI.

JEL Codes: C14, C30, C32, C33, I15, I25, O15

Keywords: Human Development Index, Granger Causality, Fixed-Effect Panel Data Models, SUR Estimates

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1. Introduction

Development has generally been considered synonymous with economic growth, with developing countries defined as those experiencing great advances in GDP expansion (Myint, 1958). Per capita income change has been regarded as an indicator of this economic development (Bilbao-Ubillos, 2012). Subsequently, Amartya Sen made his contribution to this field with his capabilities approach, followed later by the United Nations Development Program's introduction in 1990 of the Human Development Index (HDI), a composite index. The capabilities approach is implicit in the methodology going into the HDI, and it emphasizes ends (capabilities) over means. Countries are ranked in the Index according to their scores on health, longevity, and education (HDR, 2016).

The HDI lays out three overall dimensions for assessment: leading a long and healthy life, acquiring knowledge, and achieving a decent standard of living. In the case of Northern Cyprus, it has been ostracized by the international community, so its economic data have not entered into the calculations of United Nations agencies, although HDI has been measured for similar territories. Starting in the 1960s, the original Republic of Cyprus experienced great turbulence and inter-communal violence, which had negative repercussions on both the economy and the political situation. The violence mounted to the point where Turkey felt compelled to intervene militarily in 1974 to protect the Turkish minority on the island. From this point onward, the island was divided into two separate ethnic states, with the Turkish Republic of Northern Cyprus being proclaimed in 1983. Since that year, however, no country (other than Turkey) has agreed to diplomatically recognize the new state, which has also been subject to several trade embargoes. That explains why there are no statistics put out by international organizations on the TRNC's public sector, health system, education, or economy.

Therefore, this paper breaks new ground by focusing on the HDI of Northern Cyprus. Firstly, by using any available series of the TRNC and incorporating information from the closest comparable countries, we compute the state's HDI. The nations in question are Southern Cyprus, Greece, Turkey, and three other Mediterranean economies: Malta, Tunisia, and Albania. Our time period runs from 1970 to 2017. Some variables of HDI, necessary for computing the series, were missing. In those cases, if the lacking information was in the region of 20%, we imputed the values with the Multivariate Chain Equation Technique (MICE). We display the computed HDI series of the TRNC, Turkey, Southern Cyprus, and Greece with scatter plots. Country-specific and time-specific box plots of all seven countries are also provided.

Secondly, we examine the stationarity of the HDI series of Northern Cyprus in comparison with those of Turkey, Southern Cyprus, and Greece. We find that all HDI series except Greece's have non-stationary properties. Then we test the Granger Causality of the TRNC's HDI series versus that of Turkey, and Southern Cyprus's versus that of Greece. Within this framework, causality can flow in either direction, and the HDI of one country may be an excellent predictor of that in a neighbouring country. One finding of this paper is that the HDI of Northern Cyprus has a Granger causality on that of Turkey, while the HDI of Southern Cyprus has no such effect on Greece's.

Thirdly, after finishing the descriptive statistical analysis of Northern Cyprus, we examine the relationship between HDI and GNI. For this purpose, a single Fixed-Effect Panel model is estimated for each variable. By taking into account the possible correlations between the unexplained parts of HDI and GNI, we estimate an equation system with the SUR technique. The results of both treatments are stable and show positive impacts on each other.

The plan of this paper is as follows. Section 2 presents the technical details of the HDI and gives a brief history of Northern Cyprus. Previous studies and critiques of the HDI are outlined in Section 3. In Section 4, we report the details of the descriptive statistical analysis, giving information about the data and the variables, and we explain the MICE method we employed to impute missing values of the variables. In this section, we also list our Granger Causality Test results for the TRNC vis-a-vis Turkey, and Southern Cyprus vis-a-vis Greece. Section 5 gives the determinants of the HDI and GNI using both Fixed-Effect Panel Data estimates and the SUR system equation of model estimates. The last section concludes the paper.

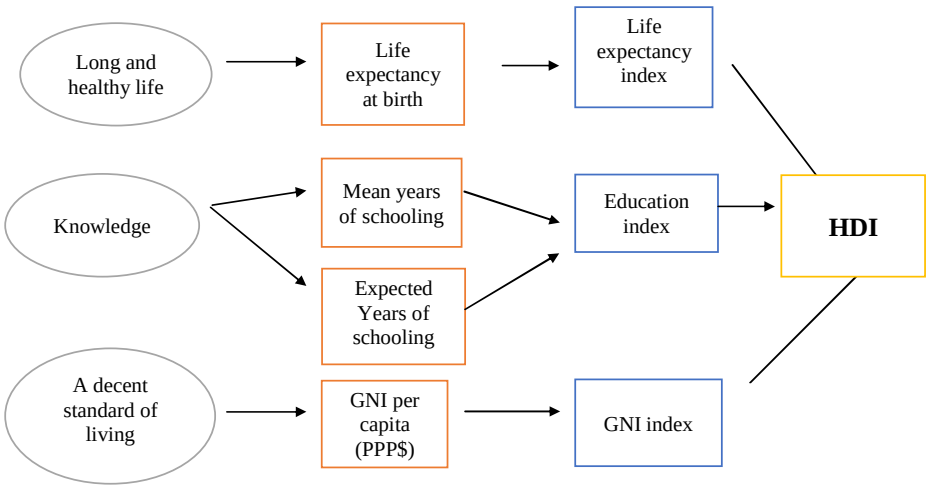
2. Construction of the HDI

The indicator for a long and healthy life is the life expectancy at birth, which is measured between 20 years and 85 years. The determination of acquired knowledge comes from both the mean years and the expected years of schooling; the mean years of schooling are between 0 and 15 years, while the expected years are between 0 and 18 years (equivalent to acquiring a Master's degree). Finally, a decent standard of living's indicator is the gross national income per capita (2011 PPP $). Its value is between $100 and $75,000 (HDR, 2016, pp. 25; HDR Technical Notes, 2016). The Human Development Index (HDI) is calculated by taking "the geometric mean of normalized indices for each of the three dimensions" (HDR Technical Notes, 2016). Figure 1 below shows the main components of the basic version of the HDI.

Table 1. HDI and Development Grouping

Human Development	**Value**
Very High Human Development	0.800 and above
High Human Development	0.700-0.799
Medium Human Development	0.550-0.699
Low Human Development	Below 0.550

Figure 1. HDI Path Diagram



In 2010—the 20th anniversary of the initiation of the Human Development Report—the UNDP amended the Index with an eye toward making its measuring more accurate (UNDP, 2010):

i. The indicators of access to knowledge and standards of living were discarded; average years of schooling replaced literacy, and expected years of schooling stood in for overall enrolment. In the category of standard of living, gross domestic product (GDP) per capita was brought in in place of the former gross national income (GNI) per capita measurement, in recognition of the major role played by international trade in a country's economy.

ii. Calculation of the three indices by arithmetic mean was changed to geometrical mean.

iii. The maximum values of the indicators were revised.

Variations of composite indices were introduced: the Inequality-Adjusted HDI (IHDI), the Gender Inequality Index (GII), and the Multidimensional Poverty Index (MPI).

In this study, we only compute the basic version of HDI.

3. Previous Studies and Critics of HDI

In 1990, the United Nations Development Program (UNDP) published the first annual Human Development Report (HDR), to be followed by the yearly publication of the HDI, which reflected the considerable contributions of Amartya Sen. It was hailed as "a universally synthetic measure of human development" that takes into consideration the capabilities approach (Booysen, 2002). That is, human development was now recognized to be not only about the income that was obtained by an individual, but also his ability to pursue his own choices, which were further defined as the freedom of well-being (evidenced by functioning and having capabilities) and the freedom of agency (having a voice and a sense of autonomy).

The capabilities approach to measuring human development rests on the concept of sets of functioning (being and doings) that can be achieved. This is a much broader approach than its counterparts: the human resource approach, the basic needs approach, and others. The Human Development Index (HDI) measures what it does according to three variables: longevity, education, and standard of living (HDR, 2016). While longevity is derived from life expectancy at birth, education "is measured by the adult literacy and the combined gross primary, secondary, and tertiary enrolment ratio, and, finally, the standard of living is measured by the real gross domestic product per capita, corrected for purchasing power" (Lind, 2003).

In the view of the UNDP, the term lifespan denotes the likelihood of people enjoying a long and healthy life. A population's access to knowledge is measured by their country's education system. As for the average standard of living, purchasing power will yield that picture. "While it is a better indicator of human development than income per capita, it is a composite index, measuring the aggregate data without interpreting and adjusting the differences between countries." (Booysen, 2002).

Sagar and Najam criticize the HDI for not taking into account the environmental side of development and for only focusing on average achievements. In addition, there is no consideration of how human development is distributed across a country (Sagar and Najam, 1998).

Huggins (2005) finds fault with the HDI's methodology for determining the quality of life in a country: external indicators cannot tell the whole story; researchers also need to learn the perceptions of those who live in that society. She further argues that since poverty and violence impair the quality of life, these should also be taken into account as a human development indicator.

One of the very few studies to be done on Northern Cyprus is Özay Mehmet's "Sustainability of Microstates: The Case of Northern Cyprus" (University of Utah, 2010). This researcher surveys economic development in the TRNC since 1974, concentrating on economic rationalism and institution building. He estimates an HDI score of 0.82 for the Turkish Republic of Northern Cyprus (p.71).This value is higher than our own estimate of 0.56.

Fukuda-Parr et al. (2010) have proposed an ''Economic and Social Rights Fulfilment Index'' (ESRF) that amalgamates six fundamental rights (health, education, food, housing, social security, and decent employment) from homogenous international statistical datasets.

Bilbao-Ubillos (2012) summarizes the defects in the HDI as follows: it overlooks those segments of the population not benefiting from national development; it ignores the gender gap in living conditions; through averaging, it masks the existence of the few high-income families who may dominate an economy; it distorts the required conditions for political stability; no notice is taken of the presence or absence of personal safety in a given society or whether there are opportunities for participating in political and social life; environmental problems are nowhere mentioned; and, finally, the HDI is static and only an average measure of the current level of the country.

Other critics of the HDI take issue with other aspects of it. For example, the three main components of the HDI—income, education, and health—contribute equally to it. This weighting appears to have been done on an *ad hoc* basis, lacking as it does any theoretical justification.

We plan to develop objective weights that will be based on the observed macroeconomic series when calculating the HDI series, to be published in a work that will follow this study. In this way, the obtained weights will be statistically objective and repeatable. It will also be possible to add both an environmental perspective to the notion of human development as well as a view of how evenly or unevenly development is spread across a given country. We hope to improve the theorizing surrounding the components of the HDI.

4. Descriptive Statistical Analysis of Data and Variables

The aim of this paper is to calculate a correct value for the TRNC. The data on the country's life expectancy at birth and GNI per capita (2011 PPP $) are publicly available from the TRNC State Planning Organization for the years 1970 to 2016. However, given that the HDI was first introduced in 1990, we decided to calculate values for the TRNC prior to 1990 as well, going back as far as 1970.

In this paper, only the calculation of the HDI for the TRNC will be explored. Figures on life expectancy at birth and GNI (formerly known as GNP—and still referred to by that term in TRNC data—are drawn from the TRNC State Planning Organization's website. However, expected years of schooling and mean years of schooling have not yet been provided to us by the authorities, though we expect this information to be relayed to us in due course. In the interim, we rely on the Multivariate Imputation by Chained Equations Method to estimate the missing information, as well as the three indices. With the Chain Equations (MICE) method, the missing values for Albania, Malta, Tunisia, Southern Cyprus, Turkey, Greece, and Northern Cyprus are supplied. Finally, for the TRNC, five datasets are generated. Only the first dataset's HDI values appear in this study since the others yield very similar results.

Moreover, we find that to calculate the other indices, additional variables and data are needed for the TRNC. The codebook below gives details on these variables and their sources.

Table 2. Codebook

Variable	**Explanation**	**Minimum and Maximum Values**	**Time Period**	**Source**
Expected Years of Schooling	Expected years of an individual's education	0-18 years	-	-
Mean Years of Schooling	Average years of education received	0-15 years	-	-
GNI Per capita	Gross Domestic Product per individual, 2011 PPP $	$100-75,000	1970-2016	TRNC National Planning Organization
Life Expectancy at Birth	Average of female and male life expectancy at birth, years	20-85 years	1970-2016	TRNC National Planning Organization

Thus, the six countries (Albania, Malta, Tunisia, Southern Cyprus, Turkey, and Greece) with similar economies and ties to the TRNC will serve as sources for the data on expected years of schooling and mean years of schooling. The resources from which we obtained the information on the variable are listed in the following table.

Table 3. Data Sources of the Variables

	Source
Expected Years of Schooling	UNESCO
Mean Years of Schooling	Barro & Lee, UNESCO
GNI per capita	World Bank, IMF
Life Expectancy At Birth	UNDP, UNESCO

In the data set, there are a total of 329 observations for nine variables. The data set covers a period of 47 years, between 1970 and 2016, for seven countries. The label IH stands for Indicator Index for Health; E for an average of Expected and Mean Education years; IE denotes Indicator Index for Education; II represents the Indicator Index for Income; and HDI is the acronym for the Human Development Index, which is calculated in this study. These are the overall results for all the studied countries.

Table 4. Descriptive Statistics of the Variables Used in the Study, All Countries

	Year	Life Expectancy	Expected Schooling	Mean Schooling	IH	E	IE	II	HDI	GNI per capita $
Minimum	1970	51.15	5.282	1.354	0.00	3.539	0.00	0.00	0.00	1,274
1st Quartile	1981	71.53	9.507	6.051	0.6605	7.650	0.4539	0.07241	0.2534	3,768
Median	1993	74.15	11.231	6.741	0.7456	8.989	0.6017	0.17610	0.4236	7,340
Mean	1993	72.84	10.553	7.108	0.7033	8.830	0.5842	0.26893	0.4335	10,537
3rd Quartile	2005	77.04	12.271	8.915	0.8393	10.091	0.7234	0.40568	0.6066	15,248
Maximum	2016	82.00	14.179	11.904	1.00	12.596	1.00	1.00	0.9889	35,720

Interpreting the overall characteristics of all countries in the group on a group basis would produce a distorted picture, so we have elected not to make an evaluation. In Table 5 below, we report the values pertaining only to Northern Cyprus.

The country's GNI series has a greater mean value than the median, $6,022 versus $3,842. It shows a right skewed distribution. The other series have more or less very similar mean and median values, i.e., the series have symmetric distributions. The only exception is the HDI series, where the mean is 0.3279, while the median is 0.2962.

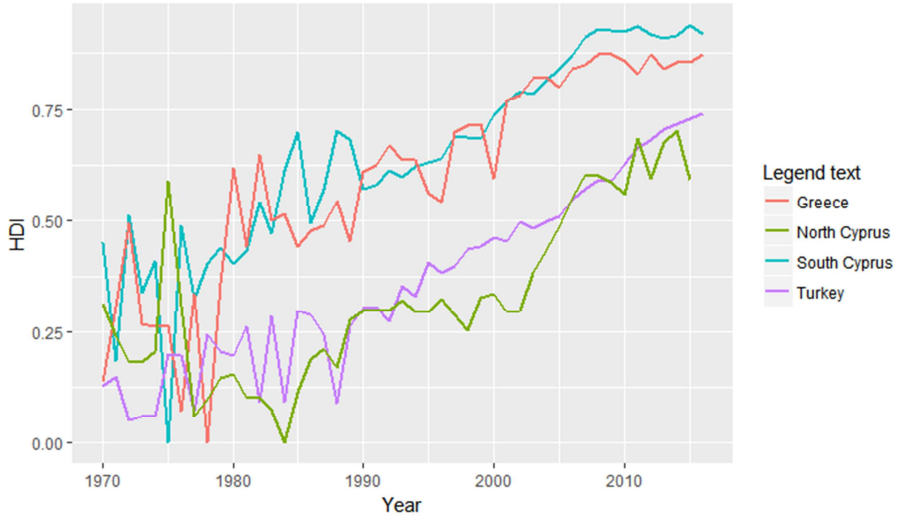
Table 5. Descriptive Statistics of the Variables Used in the Study, Northern Cyprus

	Year	Life Expectancy	Expected Schooling	Mean Schooling	IH	E	IE	II	HDI	GNI per capita $
Minimum	1970	59.98	5.357	2.084	0.2863	4.889	0.1490	0.00000	0.0000	1,274
1st Quartile	1981	72.82	8.691	6.051	0.7025	7.356	0.4214	0.02158	0.1840	2,018
Median	1992	73.61	11.105	6.548	0.7282	8.888	0.5906	0.07454	0.2962	3,842
Mean	1992	73.65	10.215	6.848	0.7294	8.532	0.5512	0.13783	0.3279	6,022
3rd Quartile	2004	74.50	11.747	6.741	0.7569	9.417	0.6489	0.25184	0.4723	9,949
Maximum	2015	82.00	14.179	10.986	1.000	11.367	0.8642	0.43210	0.7020	16,158

In the Appendix, Table A, we report the whole series for Northern Cyprus.

Below, the HDI series of Northern Cyprus, Turkey, Southern Cyprus, and Greece are plotted on the same graph.

Figure 2. HDI for Northern Cyprus, Turkey, Southern Cyprus, and Greece, 1970-2016



Southern Cyprus and Greece are starting with an HDI of 0.50 and reaching 0.90 in 2016. Northern Cyprus and Turkey reach 0.63 in 2016, having begun at 0.125 HDI. The difference remains almost constant as a parallel line. Southern Cyprus's HDI values are generally higher than those of Greece. The curves of these two countries run very close to each other during 1995 and 2005, but before and after this period, Southern Cyprus shows a better HDI performance. The situation for the TRNC and Turkey is different. Generally, Turkey has better HDI scores than Northern Cyprus. The HDI values of these two countries are almost identical in 1985 and 1995, and in 2000 and 2005.

The HDI curves of the four countries display slow turning points. Taking into account this persistence, we can conclude that the HDI series of these four countries may have non-stationary characteristics. We will test the stationarity of the HDI scores of these countries below. First, we look at the boxplots of the HDI scores.

The boxplot scores of HDI show the median-related dispersions for the seven countries in Figure 3. All values over the 47 years for each country are used for visualizing the boxes. The lower edges of the boxes show the first quartile values of the HDIs. The upper edges of the boxes contain the upper quartile values of the HDIs. The midlines in the boxes are the median values of the HDIs. The lowest values of the vertical lines are the minimum values of the HDI scores, while the highest values of the vertical lines are the maximum values of the HDI scores.

Southern Cyprus and Greece have the higher HDI scores, while Malta's is at a medium level. The other four countries—Albania, Northern Cyprus, Tunisia, and Turkey—have the lowest HDIs.

Figure 3. Country-specific Boxplots of HDI

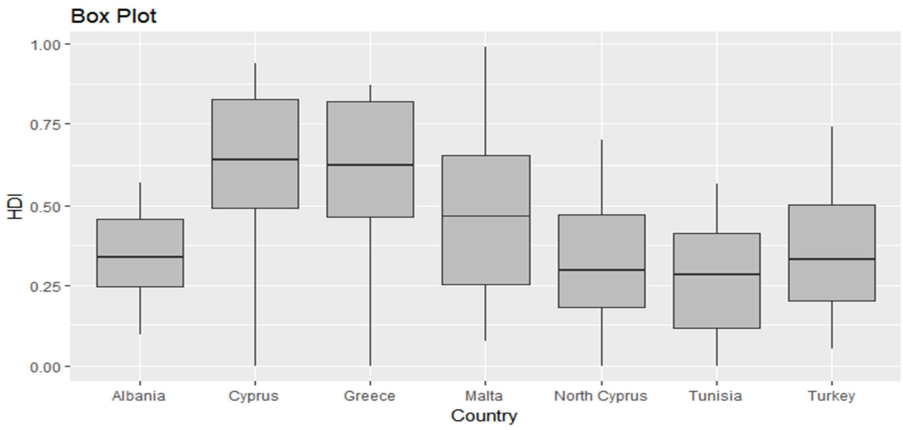
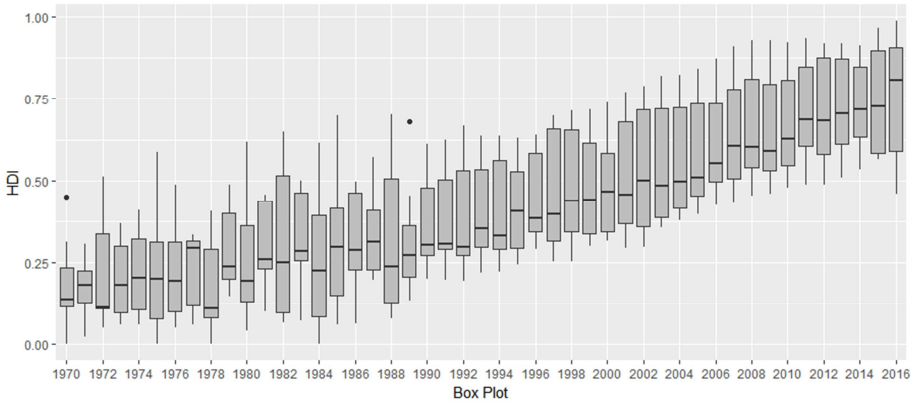


Figure 4 below depicts the HDI scores of all seven countries over 47 years. They can be seen to move up and down over the 20 years between 1970 and 1990. But after the 1990s, we note an ever-rising trend. Two dots over the vertical edges show extreme values for those years.

Figure 4. Year-specific Boxplots of HDI



4.1 Augmented Dickey Fuller Test Statistics of the HDI

We would like to examine whether the HDI scores of Southern Cyprus vs. Greece and Northern Cyprus vs. Turkey can be put in a Granger Causality context. For this purpose, we first test the stationarity of the HDI series for these four countries. Table 6 below reports the Augmented Dickey Fuller Test results. We cannot reject the null hypothesis of non-stationarity of the HDIs, except in the case of Greece. So we decide to take the first differences in the HDI series to arrive at the Granger Causality.

Table 6. Augmented Dickey Fuller Test Statistics of HDI

	Greece	Southern Cyprus	Turkey	Northern Cyprus
Dickey Fuller Test	-4.2627	-2.3013	-1.7102	-1.8268
Lag Order	3	3	3	3
p-value	0.01	0.454	0.6892	0.6428

4.2 Granger Causality Test Statistics of the HDI

The Granger Causality Test results indicate that Northern Cyprus's HDI strongly presages that of Turkey. However, the reverse is not true. The higher income and education levels of Northern Cyprus compared to Turkey may account for this phenomenon. Such a significant relationship does not exist between Southern Cyprus and Greece.

For the Granger Causality test, the first lag values of differentiated HDI scores of the second country are used as an explanatory variable in the HDI equation of the first country.

Table 7. Granger Causality Test Results

	S. Cyp $HDI to Greece $HDI	Greece $HDI to S. Cyp $HDI	TRNC $HDI to Tur $HDI	Tur $HDI to TRNC $HDI
Res. Df Model 1	42	42	41	41
Model 2	43	43	42	42
Df, Model 1	-	-	-	-
Df, Model 2	-1	-1	-1	-1
F, Model 1	-	-	-	-
F, Model 2	1.2758	0.4045	3.6914	0.6613
Pr (>F), Model 1	-	-	-	-
Pr (>F), Model 2	0.2651	0.5282	0.06166	0.4208

5. The Results of HDI and GNI Model Estimates

In this section, we examine the relationship between HDI scores and GNI values of all seven countries. We expect that these two variables are positively associated with each other. Although the GNI is used in the calculation of the Human Development Index, it is accounted together with the other two factors, education and health. We believe the single impact of HDI on GNI to be an important matter, so we look at this closer in this section. The main reason for studying the effect of HDI on income and on other variables separately is it may give a sharper picture of the countries' human development levels.

We estimate first a Fixed-Effects of Panel Data Model for HDI and GNI and then look at their structural relationships using an SUR model.

5.1 Panel Data Fixed-Effect Estimates

5.1.a. HDI

Table 8. Panel Data Fixed-Effect Estimates of HDI

	Estimate	Standard Error	t-value	Pr (> ltl)
GNI per capita	1.9625e-05	5.2028e-07	37.7202	< 2.2e-16
Expected Schooling	1.0454e-02	1.7633e-03	5.9287	7.973e-09
Mean Years of Schooling	9.7738e-03	2.3771e-03	4.1117	5.008e-05
Life Expectancy	1.0049e-02	9.4715e-04	10.6092	< 2.2e-16

All variables within the HDI equation have significant impacts on the HDI scores. This is an expected result since these variables are also used to derive the HDI series.

5.1.b. GNI

Table 9 Panel Data Fixed-Effect Estimate of GNI per Capita

	Estimate	Standard Error	t-value	Pr (> ltl)
HDI	33337.66	723.64	46.069	< 2.2E-16

The model of GNI gives the parameter estimate in Table 9. The impact of HDI is positive significant on GNI. We did not use the other two components of HDI on the right-hand side because of the high correlation between them. The significantly estimated positive impact of HDI on the Gross National Income per capita is important and thus supports the use of the HDI index as a rough measure of the human development level of a country.

A common problem in regression is to predict a future response of a dependent variable (HDI) from a known value of the explanatory variable (GNI). Often, however, there is a need to do the reverse; that is, given an observed value of the response (HDI = HDI_0,), estimate the unknown value of the explanatory variable (GNI = GNI_0). Such a problem is known as the calibration problem, and more generally, as an inverse estimation. In simple terms, it involves the use of an observed value of the response (HDI) to make an inference of the corresponding unknown value of the explanatory variable (GNI). The second Fixed-Effects Panel Model of GNI can be seen as an inverse estimation case.

However, estimating such a single equation panel data model of HDI and GNI misses the possible correlation of the error terms of the variables. To remedy this problem, we re-estimate below the same equations, this time, in an SUR equation system framework.

5.2 Seemingly Unrelated Regression Model Estimates

The first two tables, Table 10.a. and Table 10.b. give the general information about system equation estimation results. Two dependent variables are correlated negatively, and the models are estimated with very high R^2 values.

Table 10.a. Seemingly Unrelated Regression Model Estimates

	N	DF	SSR	detRCov	OLS-R2	McElroy-R2	MSE	RMSE	R2	Adjusted R2
system	656	640	2.342 +09	7.2401	0.906113	0.999992	-	-	-	-
HDI	328	320	1.83116e	-	-	-	5.72200e-03	0.075646	0.905056	0.902980
GNI per capita	328	320	2.34200e +90	-	-	-	7.31874 +06	2705.316066	0.906113	0.904059

Table 10.b. Seemingly Unrelated Regression Model Estimates, the Correlations of the Residuals

	HDI	GNI per capita
HDI	1.00	-0.999914
GNI per capita	-0.999914	1.00

In both models, all of the parameters are estimated significantly. Both impacts, that of HDI on GNI and that of GNI on HDI, are positive. The only differences are on the signs of country-specific parameters. These are positive in the first equation of HDI and negative in the second equation of GNI.

Table 11.a. SUR Estimates for HDI

	Estimate	Standard Error	t-value	Pr (> ltl)
Albania	1.87302e-01	1.11026e-02	16.87017	< 2.22e-16
Southern Cyprus	1.44305e-01	1.31537e-02	10.97064	< 2.22e-16
Greece	1.59218e-01	1.26507e-02	12.58567	< 2.22e-16
Malta	9.92537e-02	1.22416e-02	8.10787	1.1102e-14
Northern Cyprus	1.59928e-01	1.12554e-02	14.20903	< 2.22e-16
Tunisia	1.21360e-01	1.10939e-02	10.93934	< 2.22e-16
Turkey	1.06267e-01	1.15181e-07	67.39678	< 2.22e-16
GNIper capita	2.78933e-05	4.13867e-07	67.39678	< 2.22e-16

Table 11.b. SUR Estimates for HDI

Residual Standard Error	0.075646
Degrees of Freedom	320
Number of Observations	328
SSR	1.831157
MSE	0.005722
Root MSE	0.075646
Multiple R-Squared	0.905056
Adjusted R-Squared	0.90298

Similarity of parameter estimates in both Fixed-Effects Panel Models and SUR Models shows the parameter stability of the relationship between two main factors. The overall conclusion of this exercise is that the HDI as an index gives a rough approximation of the GNI; in turn, the calculated HDI values may also be used as an inverse relation for predicting the GNI series. We are still left with the problem of equal contributions from income, education, and health to the calculated HDI series. This treatment lacks theoretical

support and thus is an *ad hoc* procedure. It should be improved, perhaps with objective weights to discern the relationship between components of the calculated HDI series. A Principal Component Procedure with a Latent Variable Treatment may work to obtain such objective weights. These weights, in turn, could be used to predict the latent HDI scores. Such a repeatable procedure might also lead to a better theorizing of the HDI and its components.

Table 12.a. SUR Estimates for GNI per Capita

	Estimate	Standard Error	t-value	Pr (> ltl)
Albania	-6654.460	428.746	-15.5207	< 2.22e-16
Southern Cyprus	-5059-882	516.948	-9.7880	< 2.22e-16
Greece	-5602.986	500.555	-11.1935	< 2.22e-16
Malta	-3473.729	464.123	-7.4845	7.0122e-13
Northern Cyprus	-5675.795	429.191	-13.2244	< 2.22e-16
Tunisia	-4302.489	414.631	-10.3767	< 2.22e-16
Turkey	-3745.443	433.782	-8.6344	4.4409e-16
HDI	35674.705	529.324	67.39678	< 2.22e-16

Table 12.b. SUR Estimates for GNI per Capita.

Residual Standard Error	2705.316066
Degrees of Freedom	320
Number of Observations	328
SSR	2341995204.75119
MSE	7318735.014847
Root MSE	2705.316066
Multiple R-Squared	0.906113
Adjusted R-Squared	0.904059

6. Conclusion

The HDI has been calculated by the United Nations Development Program (UNDP) since 1990 as a measure of human development, and it ranks countries according to a score between zero and one. Northern Cyprus has been left out of this exercise, although similar territories have been included. Thus, we calculated the Human Development Index value of the TRNC. We generated the information on expected years of schooling and mean years of schooling by applying the MICE method to values derived from Albania, Malta, Tunisia, Southern Cyprus, Turkey, and Greece. As shown in the Comparison

graph, the TRNC's values somewhat mirror those of Turkey. However, the data used to estimate the two variables could be missing certain values. In further studies, using the indices of education, health, and standard of living for other countries and including more explanatory variables would produce much better estimations.

At the same time, we discussed the Granger Causality of HDI in Northern Cyprus and Turkey. The finding indicates that the HDI of Northern Cyprus has predictive indicators for Turkey's, although the relationship does not work in reverse.

We also examined the relationships between HDI and GNI using separate Fixed-Effect Panel Models and Seemingly Unrelated Regression. Findings were very robust, and the impacts of each factor on the other dependent variable were significantly positive. This means HDI is working as an index to measure the human development level in a society.

Finally, the fixed weighting problem of the HDI is a leading issue to be further investigated. We criticize the calculation of HDI. The three main components of the HDI—income, education, and health—are contributing equally to the index. The decision to set it up on this basis appears to have been an *ad hoc* one, lacking as it does any theoretical underpinning. The calculation of the HDI needs to be improved by incorporating into the methodology of compiling it objective weights, which would then reveal the relationship between components of the calculated HDI series. In our next study, we plan to develop some of these objective weights by means of the observed macroeconomic series in order to calculate the HDI series. In this way, the obtained weights will be statistically objective and repeatable. Furthermore, the addition of the environmental aspect to the overall profile of a country's human development will be possible, as will the evenness or unevenness of the countrywide distribution of well-being (as mentioned in Sagar and Najam, 1998). A Principal Component Procedure with a Latent Variable Treatment may work to obtain such objective weights. These weights, in turn, can be used to predict the latent HDI scores. Such a repeatable procedure may also lead to a better theorizing of the HDI and its components.

Appendix

Table A. Variables of Northern Cyprus

Year	GNIP	Life Expectancy	Expected Schooling	Mean Schooling	IH	IE	II	HDI
1970	3920	71,7	11,4811	6,33575	0,66618	0,5928	0,07682	0,311877865
1971	6190	59,98	11,10489	2,16153	0,28634	0,34159	0,14272	0,240779718
1972	1757	72,761659	11,69154	6,67524	0,70059	0,62316	0,01402	0,182932563
1973	2400	72,576	5,53813	6,33575	0,69457	0,26471	0,03269	0,181815412
1974	2720	73,53	5,53813	6,5916	0,72549	0,27884	0,04198	0,204019126
1975	13480	74,5	10,78478	10,02511	0,75693	0,75804	0,35435	0,588021734
1976	3343	74,352	12,26402	6,5043	0,75213	0,64533	0,06007	0,307774393
1977	1444	59,98	6,00119	3,77662	0,28634	0,149	0,00494	0,059491631
1978	1463	65,214	11,92652	2,08351	0,45597	0,38264	0,00549	0,098556349
1979	1556	71	11,92652	6,05107	0,64349	0,60168	0,00819	0,146894687
1980	1561	72,55	12,06477	6,5916	0,69373	0,63915	0,00833	0,154589002
1981	1435	72,55	6,32491	6,5916	0,69373	0,32227	0,00467	0,10147684
1982	1361	72,55	11,1781	6,5916	0,69373	0,5902	0,00253	0,101124538
1983	1305	72,55	12,26402	6,5916	0,69373	0,65015	0,0009	0,074041537
1984	1274	72,55	11,92652	6,05107	0,69373	0,60168	0	0
1985	1498	74,6	6,32491	6,05107	0,76017	0,29243	0,0065	0,113070204
1986	1757	74,6	11,4811	6,74145	0,76017	0,6152	0,01402	0,187173776
1987	2009	74,6	10,68521	7,1138	0,76017	0,59182	0,02134	0,212527757
1988	2043	74,6	6,19654	6,05107	0,76017	0,28535	0,02232	0,16918278
1989	2513	74,6	11,57217	9,2819	0,76017	0,76048	0,03597	0,274985369
1990	3447	74,5	10,73086	6,2287	0,75693	0,54548	0,06308	0,296426363
1991	3116	74,5	12,29533	6,74145	0,75693	0,66015	0,05348	0,298962165
1992	3343	74,5	10,73086	6,67524	0,75693	0,57013	0,06007	0,295948378
1993	3528	74,5	12,29533	6,74145	0,75693	0,66015	0,06544	0,319769957
1994	3093	74,5	11,35365	7,1138	0,75693	0,62872	0,05281	0,292910762
1995	4167	74,5	8,25401	6,05107	0,75693	0,39893	0,08399	0,293801459
1996	4222	73,014	11,10489	6,05107	0,70877	0,55632	0,08558	0,32315067
1997	3763	73	9,6959	5,92991	0,70831	0,47184	0,07226	0,289047953
1998	4361	73	5,35749	6,33575	0,70831	0,25474	0,08962	0,252875731
1999	4666	73	9,86431	6,33575	0,70831	0,50355	0,09847	0,327486855
2000	4978	73	9,9026	6,05107	0,70831	0,48994	0,10753	0,334170358
2001	4303	73,3	8,03346	6,33575	0,71804	0,40247	0,08793	0,293999955
2002	4409	73,3	8,35621	6,05107	0,71804	0,40457	0,09101	0,297906984
2003	5949	73,3	11,49732	6,05107	0,71804	0,57798	0,13572	0,38332571
2004	8095	73,3	11,05183	6,33575	0,71804	0,5691	0,19802	0,432529701
2005	10567	73,3	11,44794	6,33575	0,71804	0,59097	0,26978	0,48556078
2006	11837	73,7	14,17937	6,5043	0,731	0,75107	0,30665	0,552181841
2007	14765	73,85	11,74678	9,2819	0,73586	0,77012	0,39166	0,605460786
2008	16158	74,05	12,76189	6,67532	0,74234	0,68226	0,4321	0,602621587
2009	13930	74,15	11,16188	9,2819	0,74558	0,73783	0,36742	0,586862378
2010	14703	74,35	11,10262	6,74145	0,75207	0,59431	0,38986	0,55854354
2011	15403	81,3	11,74678	9,86817	0,97731	0,80248	0,41018	0,68519483
2012	15038	81,35	7,07707	9,78295	0,97893	0,53998	0,39958	0,595541921
2013	15302	81,4	11,10262	9,86817	0,98055	0,76692	0,40725	0,674051533
2014	15109	81,9	11,74678	10,98638	0,99676	0,86422	0,40164	0,702022193
2015	13721	82	7,03279	10,47322	1	0,57564	0,36135	0,592506403

MICE Imputation Method

Since the expected years of schooling and mean years of schooling of the TRNC are not available for this paper, the seven countries given in the data and variables section are used to estimate those missing values. Thus, to fill in the missing values, the Multivariate Imputation by Chain Equations (MICE) method is used to generate partially synthetic data sets. Five data sets are created by this method for the missing values from information gotten or imputed from Albania, Malta, Tunisia, Southern Cyprus, Turkey, Greece, and Northern Cyprus.

The data sets of these countries with some observed values are replaced with multiple imputations. We generate data through chained equations (also known as fully conditional specification—FCS) and sequential regression multivariate imputation (SRMI), their advantages being:

- No requirement of an explicit assumption for the joint distribution of the data set, i.e., conditional distributions are specified for each variable separately

- Imputations are based on univariate distributions, allowing for different models for each variable

- Continuous variables can be imputed using a normal model, and binary variables can be imputed with a logit model

- Empirical data will seldom follow a standard multivariate distribution

- It is a flexible tool to account for bounds, interactions, skip patterns, or constraints between different variables

- It is very easy to address missing-data problems and confidentiality problems at the same time when generating partially synthetic data sets. Even when the imputation model and the analyst's model contain different numbers and types of variables, the results will still be valid (Drechsler, 2011).

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