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Comparison of Equality and Levels of Wellbeing Across the Former USSR Countries Pre and Post Dissolution

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1. Preface

Previous researches concerned mainly with micro-equality in human development. We believe that macro-equality levels as well important to address the variatioins of wellbeing across united or local areas. Macro-equality sometimes reflects the micro-equality level in areas where different population groups live in different areas. Inequality across local areas might initiate conflicts between marginalized areas and the federal governments. For these reasons and others, there is a need for more emphasis on macro-equality issues; and for developing robust indicators to measure and monitor it.

The objective of this paper is to discuss macro equality in wellbeing and its levels across the former USSR countries before and after dissolution date (1991). The case of the dissolution of USSR states is a good example to examine the pre and post macro-equality in human development across these countries, and to find out the gainers countries, and the losers ones. Moreover, this would be a good chance to evaluate the merits and shortcomings of unity and independency.

We are going to measure equality issues in this paper by macro-equality indices and methods that we developed. These are: First, an index to measure macro-equality level in different variables within subdivisions of a region or between regions; Second, a method to evaluate the improvement power of equality across these units. More over we defined new concepts of equality to differentiate between equality and variability, and to classify equality into different types. The methodology and concepts of these developments were illustrated in two papers: the first paper was presented in the 2015 IARIW-CAPMAS Conference in Cairo in which we discussed macro-equality in wellbeing across Sudan states as example. The second one was written for the 2018 IARIW general conference in Copenhagen in which we discussed wellbeing in the European Community Countries as an example. For this paper the main subject would be devoted to the analysis and discussion of the results of application of this method for the former USSR

countries pre and pro dissolution situations. The details of the method used are presented in the Appendices.

We are going to use for the analysis the human development index (HDI) for the concerned countries in different years. These years include some years around the dissolution date, and other years after this date up to 2017. The data for these indicators have been obtained from the United Nations and World Bank websites (Appendix 1 and Appendix 2). However there are some gaps in these data for some countries especially at earlier years but we managed to make best possible estimations.

Our discussion is based on finding an answer to four questions: First, to what extend was the change of equality and human development levels across these countries during these periods? Second, what was the extent of change in levels and trends of human development in the former USSR countries pre and post dissolution? Third, which countries were the gainers and the losers? Fourth, what is the impact of dissolution on human development and equality levels across and in former USSR' countries.

2. Definition of Concepts

We introduce here the concepts we defined to differentiate between macro-equality and variability, and to classify macro equality into different types. Macro-equality concept is concerned with linked subdivisions which are tied by inter-beneficial commitments, for example states or districts; whereas variability is concerned with independent units, for example countries. Macro-equality is classified into four types: enforced, induced, inertial and chance. Enforced equality is developed by deliberate actions. Induced equality is developed by association of the concerned variable with other variables. Inertial equality is the case where the variable values have an upper bound; in this case the more the approach of the variable values of units to this bound the higher the equality level across them. Chance is the case where equality developed by pure chance; this is likely to be the case of independent units, the case which we defined as variability rather than equality. However, sometimes underdeveloped countries might be supported by international programs to be pushed towards fixed target of human development level; in this case the achievements from these programs could lead to an equality level that can be described as enforced macro-equality.

3. Methodologies

As mentioned in the preface, we developed an index to measure macro-equality level in different variables within subdivisions of a region or between regions; and a method to measure the improvement power of equality across these units; and a system to monitor macro-equality through time. The illustration of these methods is found in Appendix 3. The key points of the methods are as follows:

1- The mean value of the percentages of different variables' values from their totals would be equal for all variables provided that the number of cases is equal for all variables.
2- A Macro-Equality Index (MEI) with comparability validity was developed from the percent values of a variable or more to measure macro-equality in these variables across subdivisions of a region, or across regions with equal number of subdivisions.
3- The mean and standard deviation of the percentages of values of a variable are defined as standardized mean (SM) and standardized standard deviation (SSD)
4- The Macro-Equality Index is calculated as follows: MEI = SM – SSD. The maximum value of MEI equals SM when SSD=0 and the minimum value equals zero when SM=SSD. The percent of MEI from SM would be used when the total number of cases is not equal for all variables.
5- The Correlation Coefficient value (CC) was used to measure macro-equality development power of a variable across units through time by correlating (the values of the variable at the base year) and (their differences from the values at a future time). A complete equality would be attained when the CC value of this relationship equals -1. A complete inequality would result when the CC of this relationship equals +1. We called the CC value in this case macro-equality correlation coefficient (MCC).

4. **The data**

The human index values for the pre and post former USSR countries have been obtained from UN website for the years 1990, 1995, 2000, and 2005 (Appendix 1); and from the WB website for the years 1990 and 2000, and from 2010 by single years to 2017 (Appendix 2). The challenge we faced in this paper was how to fill the gaps of data in some years before the dissolution. The only year before dissolution with acceptable coverage of HDI data for both UN and WB data is the year 1990, one year before dissolution. However the UN data includes data in the year 1995 which was not far from the dissolution year; but UN data in all years include gaps in information in some countries. The only year includes gaps in data with respect to WB is the year 1990. We managed to draw estimations to fill these gaps by interpolation and extrapolation (see Appendix 4-A). Also we developed a new method to evaluate estimates where there are two sets of the same data from two sources including identical reference years (see Appendix 4-B). We used this method to evaluate our estimates taking the advantage of the availability of HDI values in identical years in the UN and WB sets of data.

In our discussion we integrated the two sources of data to replace the gaps in data for some years in the two sets, taking into consideration the comparability validity between the two sources. In this respect we used the HDI values for different years from the two sources as follows:

- First; taking the years 1990 and 1995 UN HDI data to represent the 5 years period around dissolution date, and to compare it with the 2010 and 2015 WB data to represent the five years period after around 15 years of dissolution date.
- Second; taking the 2015 and 2017 WB HDI data years to represent the outcomes of HDI levels and equality situation in the latest period after dissolution according to the available of data.
- Third: taking some years between 1990 and 2017 WB HDI data to see the changes in the level of HDI in-between the years, the rank of countries, and equality situation in and across the different countries after around 17 years of dissolution.

- Forth: taking three five-year intervals of HDI data from 1990 to 2005 UN data to detect the trend of equality levels and development in HDI through the early years before and after dissolution.
- Fifth: taking two ten-year intervals of HDI data from 1990 to 2010 WB data to detect the trend of equality levels and development in HDI through some years after dissolution.
- Sixth: taking the one year interval of HDI data from 2010 to 2017 WB data to follow the gradual equality levels trend in HDI at later years after dissolution.

5. Analysis and discussion

We start first with the evaluations of our estimates by the method that we developed based on MEI values (Appendix 4). According to the requirement of this method, we have HDI data from UN and WB sources for the years, 1990 and 2000. We found that the differences between MEI values across former USSR countries in these years from the two sources were not considerably high according to the objectives of the paper. So these estimates are likely to be around the real values.

As for our analysis and discussion we divide the section into two parts: the first one concerned with levels, trends and development of equality in human development across the former individual USSR countries before and after dissolution. These levels and trends were measured by percent MEI and MCC respectively. The second one concerned with the levels and trends of human development in the former USSR countries before and after dissolution measured by HDI values and differences & orders of these values in different intervals and years.

5.1. Levels trends and development of equality: For comparability validity, because our data sources referred to two different sources with different estimates in similar years, we used data from two years with fixed interval of 5 years from each source to indicate the change in HDI values across the former USSR countries during two intervals in pre and post dissolution periods. Table 1 shows HDI values and equality indices values for the years 1990 and 1995 according to UN estimates to represent the pre dissolution period, and the HDI values for the years 2010 and 2015 according to WB estimates to represent

the post dissolution period. The shaded values are the estimated ones. Figure 1 shows a graph representation of the percent MEI in the years 1990 and 1995 as from the UN data; and the years 2010 and 2015 as from the WB data. As indicated in the graph equality in HDI across former USSR countries increased during 1990-1995, the period around dissolution date, while it decreased during 2010-2015 after a little more than 10 years of dissolution. During the five years interval around dissolution date the %MEI value increased from 92.7% in 1990 to 93.9% in 1995, while during the five years between 2010 and 2015 it increased from 90.7% in 2010 to 90.9 in 2010 with increment lower than that in 1990-1995. The power of development of equality during 1990-1995 measured by MCC value was -.58 which means that there was equality improvement during this period with 58% of improvement power. The MCC value during 2010-2015 was 0.0.036 which indicates retardation of equality during this period with backward power of 3.6% passing towards inequality direction. This is the first evidence which shows that unity is in favor of equality in human development levels across united regions. This result is likely expected when the human development services from federal or capital center to different units distributed in justice. But the question arises here is that, whether the levels of human development itself go in the same direction for all countries. This will be answered in the next section.

To increase the validity of comparability we compared between equality levels and trends from one source of data. The WB data includes HDI values for the years 1990, 2000 and 2010. Table 2 presents the equality indices for the former USSR countries in these years. Figure 2 shows the graphs of %MEI across countries in respected years. We notice in this graph that equality across these countries decreased between 1990 and 2000, and then it increased again. From the two results it could be said that the equality across the former USSR countries started to decline in 1995 after four years of dissolution, and then it started to increase again in 2000 after 5 years from the beginning of its decline. This means that equality in human development in the former USSR countries started to change from induced equality to independent equality after around 10 years from the dissolution date.

Table 1
HDI, SM, SSD, MEI and the MCC values for the former USSR countries in 1990 & 2005 and 2010 & 2015 respectively as from the UN and the WB sources

SN	Country	1990UN	1995UN		2010WB	2015WB
1	Estonia	0.813	0.792		0.845	0.866
2	Lithuania	0.827	0.791		0.824	0.852
3	Latvia	0.804	0.771		0.816	0.841
4	Russian Federation	0.815	0.771		0.780	0.813
5	Belarus	0.790	0.755		0.792	0.805
6	Kazakhstan	0.724	0.738		0.765	0.797
7	Georgia	0.690	0.729		0.735	0.771
8	Azerbaijan	0.742	0.736		0.740	0.758
9	Armenia	0.737	0.701		0.728	0.748
10	Ukraine	0.809	0.756		0.733	0.743
11	Uzbekistan	0.683	0.691		0.666	0.698
12	Turkmenistan	0.676	0.694		0.673	0.701
13	Moldova (Republic of)	0.740	0.684		0.670	0.693
14	Tajikistan	0.703	0.638		0.634	0.645
15	Kyrgyzstan	0.697	0.697		0.636	0.666
	SM	6.67	6.67		6.67	6.67
	SSD	0.48	0.41		0.62	0.61
	MEI	6.18	6.26		6.05	6.06
	%MEI	92.73	93.91		90.71	90.9
	MCC	1990 - 1995 UN	-0.58		2010 - 2015 WB	0.036

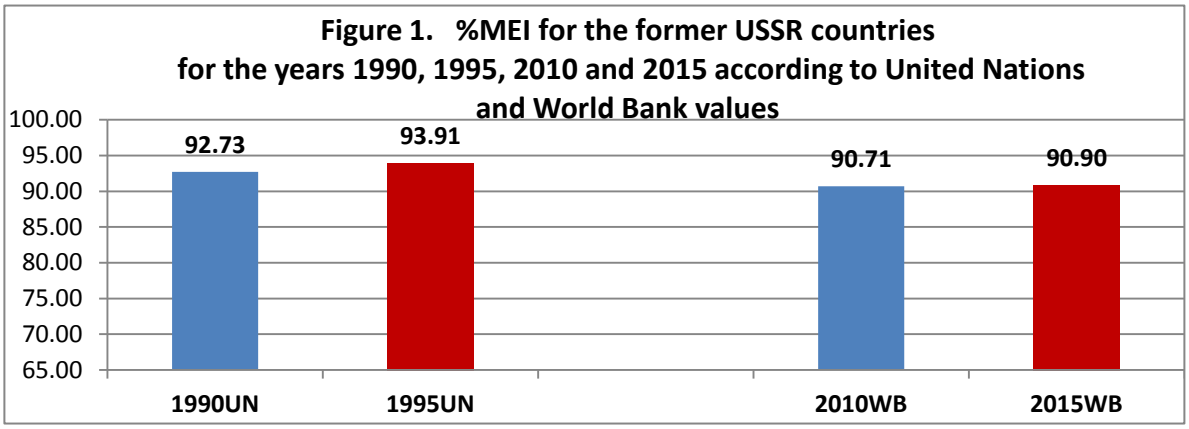
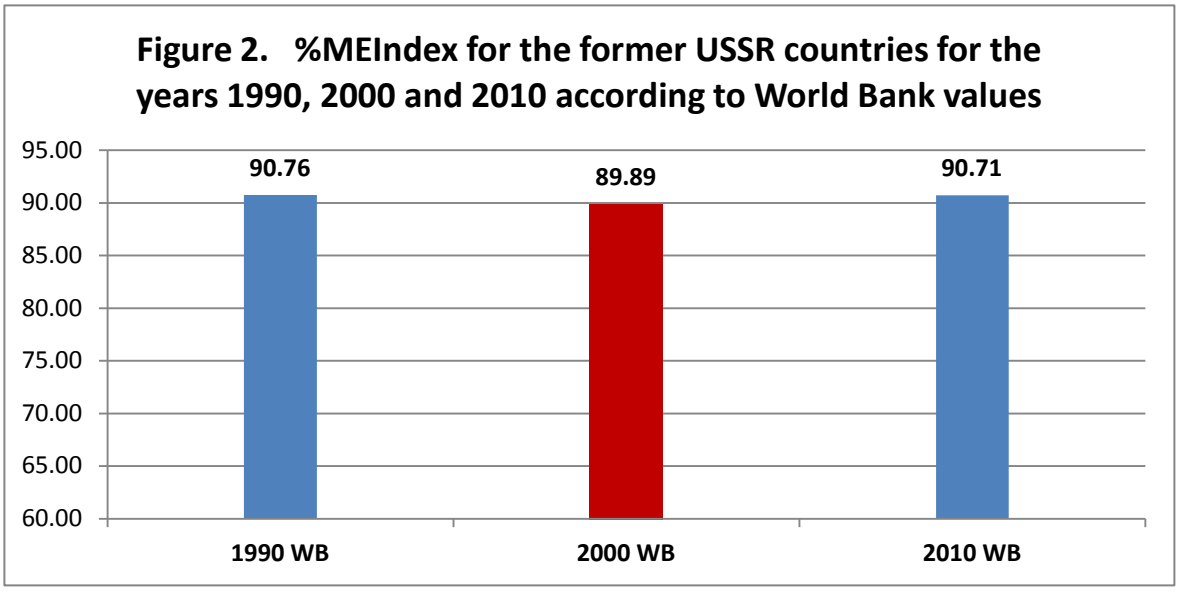


Table 2
HDI, SM, SSD, MEI and the MCC values for the former USSR countries in 1990, 2000, and 2010 from the WB sources

SN	Country	1990 WB	2000 WB	2010 WB
1	Estonia	0.733	0.780	0.845
2	Lithuania	0.732	0.756	0.824
3	Latvia	0.704	0.728	0.816
4	Russian Federation	0.734	0.720	0.780
5	Belarus	0.628	0.683	0.792
6	Kazakhstan	0.690	0.685	0.765
7	Georgia	0.642	0.673	0.735
8	Azerbaijan	0.589	0.640	0.740
9	Armenia	0.631	0.647	0.728
10	Ukraine	0.705	0.671	0.733
11	Uzbekistan	0.560	0.595	0.666
12	Turkmenistan	0.557	0.596	0.673
13	Moldova (Republic of)	0.651	0.597	0.670
14	Tajikistan	0.623	0.550	0.634
15	Kyrgyzstan	0.618	0.594	0.636
	SM	6.67	6.67	6.67
	SSD	0.62	0.67	0.62
	MEI	6.05	5.99	6.05
	%MEI	90.76	89.89	90.71
		-0.157	-0.035	



Now, to know the outcomes of equality situation in the latest period after dissolution, Table 3 presents the HDI values and the equality indices in the former USSR countries in 2015 and 2017 according to WB data. As the table shows equality development power measured by MCC started to recover between 2015 and 2017. The MCC values during this period changed its direction from inequality to equality from a value of 0.036 during 2010-2015 as Table 1 shows to a value of -0.26 during 2015-2017 as shown in Table 3. By this power the %MEI value reached 91.06% in 2017 compared to 90.90 in 2015.

Table 3
HDI, SM, SSD, MEI and the MCC values for the former USSR countries in 2015 and 2017 from the WB sources

SN	Country	2015 WB	2017 WB
1	Estonia	0.866	0.871
2	Lithuania	0.852	0.858
3	Latvia	0.841	0.847
4	Russian Federation	0.813	0.816
5	Belarus	0.805	0.808
6	Kazakhstan	0.797	0.800
7	Georgia	0.771	0.780
8	Azerbaijan	0.758	0.757
9	Armenia	0.748	0.755
10	Ukraine	0.743	0.751
11	Uzbekistan	0.698	0.710
12	Turkmenistan	0.701	0.706
13	Moldova (Republic of)	0.693	0.700
14	Tajikistan	0.645	0.650
15	Kyrgyzstan	0.666	0.672
	SM	6.67	6.67
	SSD	0.61	0.60
	MEI	6.06	6.07
	%MEI	90.90	91.06
	MCC	-0.26	

To overview the whole trend of equality in HDI levels according to the available data from the two separate sources we used UN data on HDI values by five years from 1990 to 2005, and WB data on HDI values by 10 years from 1990 to 2010 and from 2010

to 2017 by single year. To start with UN data which includes the dissolution date in its intervals Table 4-A present the macro-equality indices during these intervals. Figure 3 is a graph representation of %MEI and MCC values. As shown in the graph the equality level increased across the former USSR countries between 1990 and 1995, and then it decreased between 1995 and 2000, and continued its decrease between 2000 and 2005. The power of development of equality as shown in the table was – 0.58 in 1990-1995 leading to a higher equality level in 1995. This power sharply retarded to 0.484 towards inequality direction during 1995-2000; and it improved to 0.296 during 2000-2005. To detect the trend of equality across these countries after 2005 the WB data provides HDI values from 2010 to 2017 by single years, in addition to the years 1990 and 2000. Table 4-B and Table 4-C present the macro-equality indices values for these years. Figure 4 is the graphic representation of %MEI and MCC values. For the years before 2000 there was relatively sharp drop of equality between 1990 and 2000 reflected by WB data (from 90.76 to 89.89). However, according to UN data this drop during this period was very small (from 90.73 to 90.43). Nevertheless, the WB data is likely to be more reliable because the UN data includes several estimates. With respect to the situation through the single years from 2010 to 2007 Figure 4 shows that equality level in human development in former USSR countries dropped between 2010 and 2011, then increased between 2011and 2012, and then dropped again between 2012 and 2013 with smaller decrement than the last drop; then it increased between 2013 and 2014 with smaller increment than the last increase; and finally it started to increase gradually by very small increment from 2014 to 2017. Figure 5 shows the power of development through these intervals. As shown in the figure the power of equality development was zigzagging up and down through these intervals, taking a decreasing trend leading to MCC value of around -0.139 during 2016-2017 as shown in Table 4.C.

Table 4-A
Macro-equality indices of HDI levels across former USSR countries (UN data) from 1990 to 2005

United Nations values by five year periods from 1990 to 2005							
Year	**1990**		**1995**		**2000**		**2005**
SM	6.67		6.67		6.67		6.67
SSD	0.48		0.41		0.50		0.55
MEI	6.18		6.26		6.16		6.12
%MEI	92.73		93.91		92.43		91.78
MCC		-0.58		0.484		0.296	

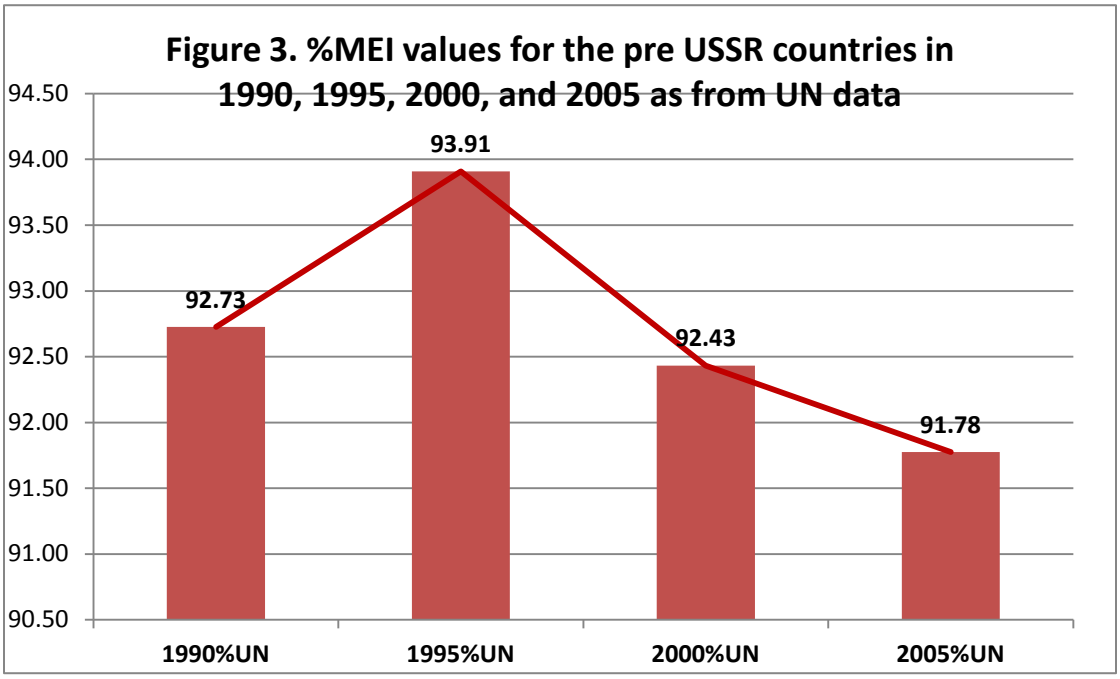
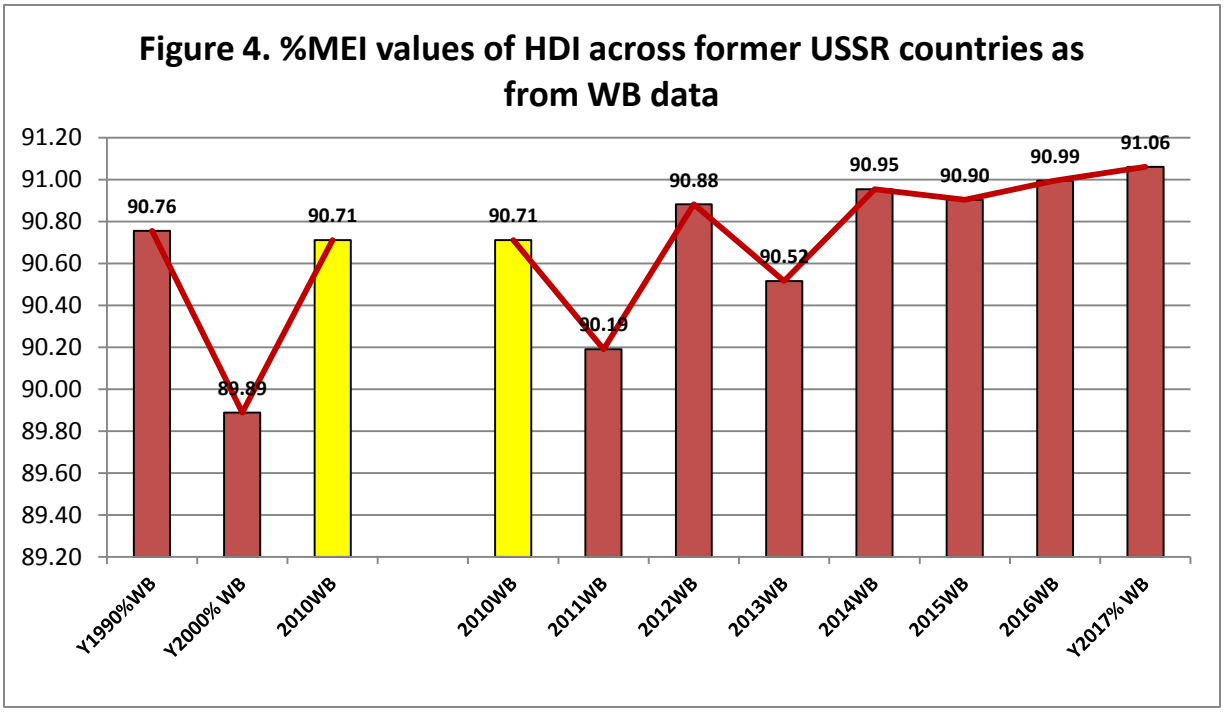


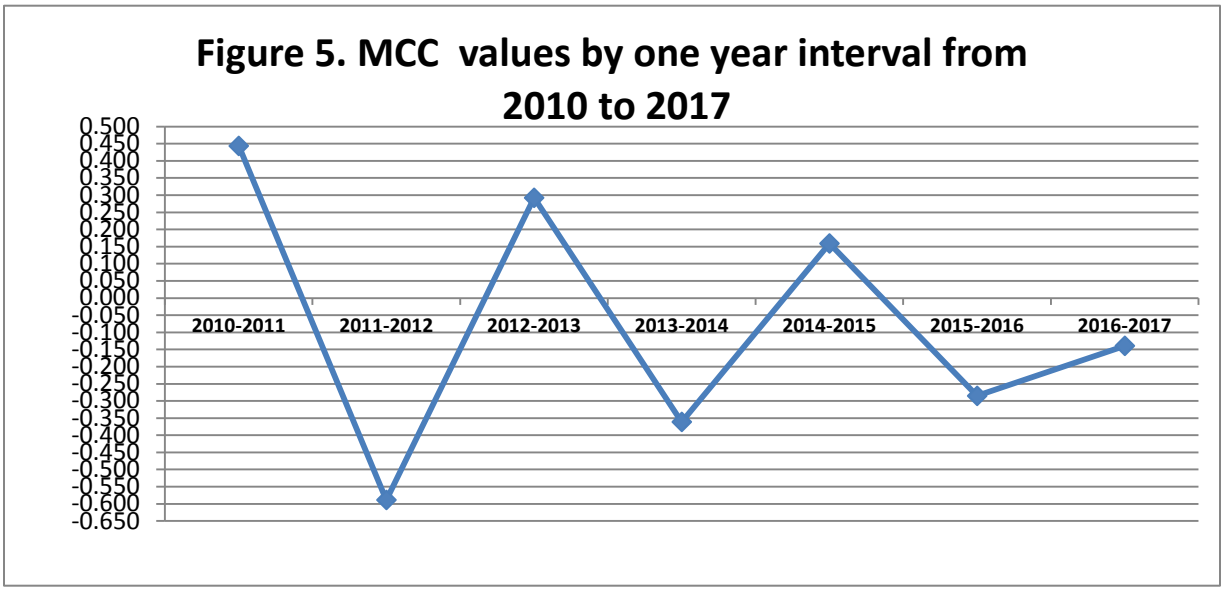
Table 4-B
Macro-equality indices of HDI across former USSR countries (WB data) from 1990 to 2000

World Bank values by 10 year periods from 1990 to 2010					
Year	1990		2000		2010
SM	6.67		6.67		6.67
SSD	0.62		0.67		0.62
MEI	6.05		5.99		6.05
%MEI	90.76		89.89		90.71
MCC		-0.157		-0.035	

Table 4-C
Macro-equality indices of HDI for former USSR countries (WB data) from 2010 to 2017

World Bank values by one year periods from 2010 to 2017								
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
SM	6.67	6.67	6.67	6.67	6.67	6.67	6.67	6.67
SSD	0.62	0.65	0.61	0.63	0.60	0.61	0.60	0.60
MEI	6.05	6.01	6.06	6.03	6.06	6.06	6.07	6.07
%MEI	90.71	90.19	90.88	90.52	90.95	90.90	90.99	91.06
MCC		0.444	-0.589	0.292	-0.361	0.159	-0.285	-0.139





We conclude from the above discussion that according to UN data equality level of HDI for the former USSR countries continued to increase for very short time after dissolution date up to 1995; then it increased again between 1995 and 2000. According to WB data, it started to increase between 2000 and 2010; then it decreased and increased alternatively with diminishing differences up to the year 2015, setting to a gradual small increase in the years from 2015 to 2017 (see Figure 4). The power of development of equality was zigzagging during this period towards equality and inequality situations reaching to equality power of -0.15 MCC value between 2016 and 2017. The value of %MEI was 91.06% in 2017 compared to 90.76 in 1990 one year before dissolution, according to WB data. This conclusion indicates that unity of the former USSR countries was in favor of equality in human development levels across them; this favor tended to decline in the years following dissolution, and revived after long-time of experiences of independent individual countries in human development. In the next section we discuss the experiences of individual countries before and after dissolution.

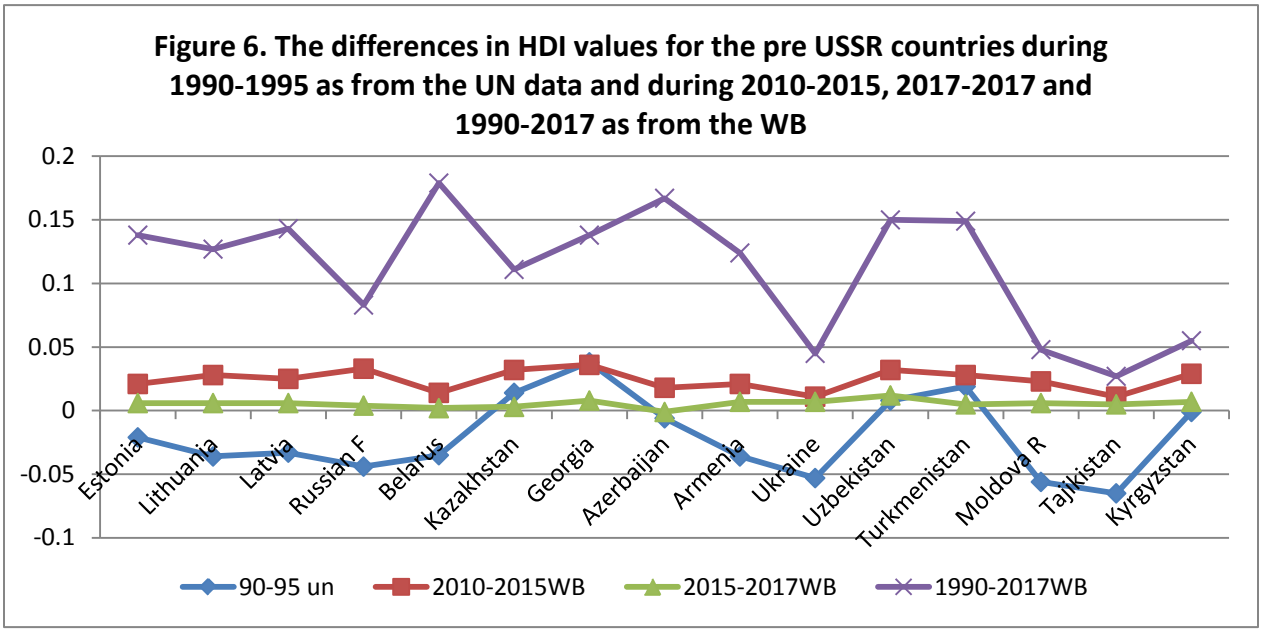
5.2. Levels and trends of human development in the former USSR countries: In this section we are going to find the pace of change of values of HDI in the former USSR countries through 1990 - 2017, and their ranks according to the level of HDI values. We first consider the levels and trends of pace of change of HDI in three intervals through the pre and post dissolution period from UN and WB data. These intervals are: during 1990-1995 as from UN data, which represents the inter-dissolution interval; during 2010-2015 from WB data, which represents the middle interval; and during 2015-2017 from WB data, which represent the last interval after dissolution according to our data; this in addition to the overall period from 1990 to 2017 according to WB data. Table 5 and Figure 6 present this information. As the graph shows all the former USSR countries experienced decrease in HDI in 1990-1995, the inter-dissolution interval, with relatively high variation between countries, except Kazakhstan, Georgia, Uzbekistan and Turkmenistan which their HDI increased during this period; however the HDI values of three of these countries were estimated values. In 2010-2015 the middle interval, the HDI values increased for all countries with relatively low variation. In the last interval (2015-2017) almost all countries showed a small increase in HDI values. This increase was lower than that shown in the middle interval for all countries, and with smaller variations between them. The resultant of these changes came out with very high increase in HDI

values between 1990 and 2017 for the former USSR countries, with very high variation among them as the graph shows. We conclude from this result that in the short time after dissolution date some countries managed to utilize their independency for more improvement in human development; in the middle interval all countries afforded to increase their efforts in this respect; in the last period when HDI values approaches its upper limit the pace of increase decreased for all countries as well as the variation in the HDI levels among them.

Table 5

The differences in change of HDI values for the former USSR countries from UN and W data during different intervals of years representing inter-dissolution period, middle period and last period after dissolution; in addition to the overall period from 1990 to 2017 as from WB data.

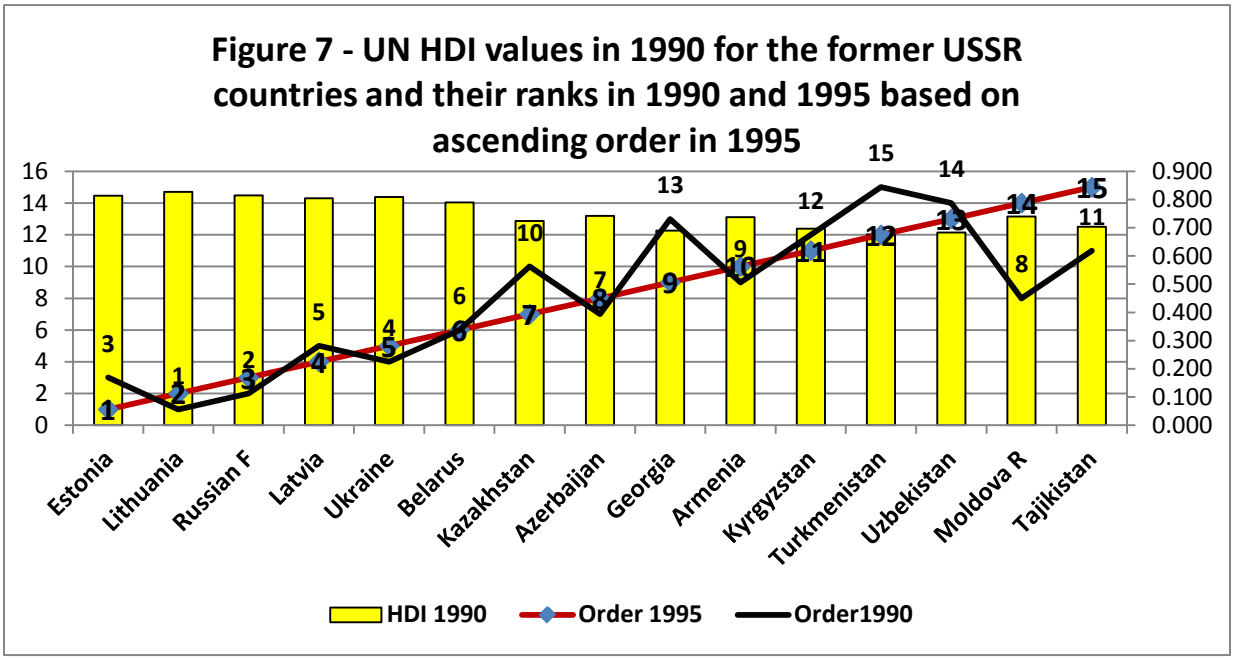
SN	Country	Differences			
		1990-1995 un	2010-2015 WB	2015-2017 WB	1990-2017 WB
1	Estonia	-0.021	0.021	0.006	0.138
2	Lithuania	-0.036	0.028	0.006	0.127
3	Latvia	-0.033	0.025	0.006	0.143
4	Russian F	-0.044	0.033	0.004	0.083
5	Belarus	-0.035	0.014	0.002	0.179
6	Kazakhstan	0.014	0.032	0.003	0.111
7	Georgia	0.038	0.036	0.008	0.138
8	Azerbaijan	-0.006	0.018	-0.001	0.167
9	Armenia	-0.036	0.021	0.007	0.124
10	Ukraine	-0.053	0.011	0.007	0.045
11	Uzbekistan	0.008	0.032	0.012	0.150
12	Turkmenistan	0.019	0.028	0.005	0.149
13	Moldova R	-0.056	0.023	0.006	0.048
14	Tajikistan	-0.065	0.011	0.005	0.027
15	Kyrgyzstan	-0.001	0.029	0.007	0.055



With respect to the ranks of HDI levels the former USSR countries were classified: First, by their ranks of HDI values in the year 1990 versus the ascending order of ranks in the year 1995 as from UN data. This interval supposed to depict the change of ranks during the short period after dissolution. Second by the 1990, 2000, 2015, 2015 WB HDI values versus the descending order of 2017 WB HDI values. This is to see the changes of the ranks of these countries through 1990 and 2017. Table 6 and Figure 7 present the UN HDI values in 1990 for the former USSR countries, and their ranks in 1990 and 1995 based on ascending order of HDI values in 1995. As shown in the graph seven of the former USSR countries their ranks in the list of HDI values were improved between 1990 and 1995, and seven of them their ranks retarded back. Only one country kept its rank during this period, and this country is Belarus (6rh rank in both years). The highest improve of the first seven countries was acquired by Georgia, from the 13^{th} rank in 1990 to the 9^{th} rank in 1995; however, the HDI values of this country in both 1990 and 1995 years based on estimation. If we exclude the estimated values in the list we find that Kazakhstan acquired the highest improvement, from 10^{th} rank in the list of 1990 up to the 7^{th} rank in the list of 1995. For the seven deteriorated countries five of them retarded by one degree in the list. The highest deterioration was experienced by Moldova (from the 8^{th} rank in 1990 to the 14^{th} rank in 1995) and Tajikistan (from the 11^{th} rank to the 15^{th} rank). If we compare the HDI values in 1990 in the graph with the ranks in 1995 we find that only two of the six countries that their DHI in 1990 equal or above 0.790 their rank improved in the list of 1995, while six of the nine countries that their DHI below 0.790 their rank improved in this list. This indicates that the increase in equality level during this period was more likely due to the improvement of human development levels in the former USSR countries with low levels of HDI values in 1990.

Table 6
UN HDI values in 1990 for the former USSR countries and their ranks in 1990 and 1995 based on ascending order in 1995

State/Country	HDI 1990	Rank 1990	Rank 1995
Estonia	0.813	3	1
Lithuania	0.827	1	2
Russian Federation	0.815	2	3
Latvia	0.804	5	4
Ukraine	0.809	4	5
Belarus	0.790	6	6
Kazakhstan	0.724	10	7
Azerbaijan	0.742	7	8
Georgia	0.690	13	9
Armenia	0.737	9	10
Kyrgyzstan	0.697	12	11
Turkmenistan	0.676	15	12
Uzbekistan	0.683	14	13
Moldova (Republic of)	0.740	8	14
Tajikistan	0.703	11	15

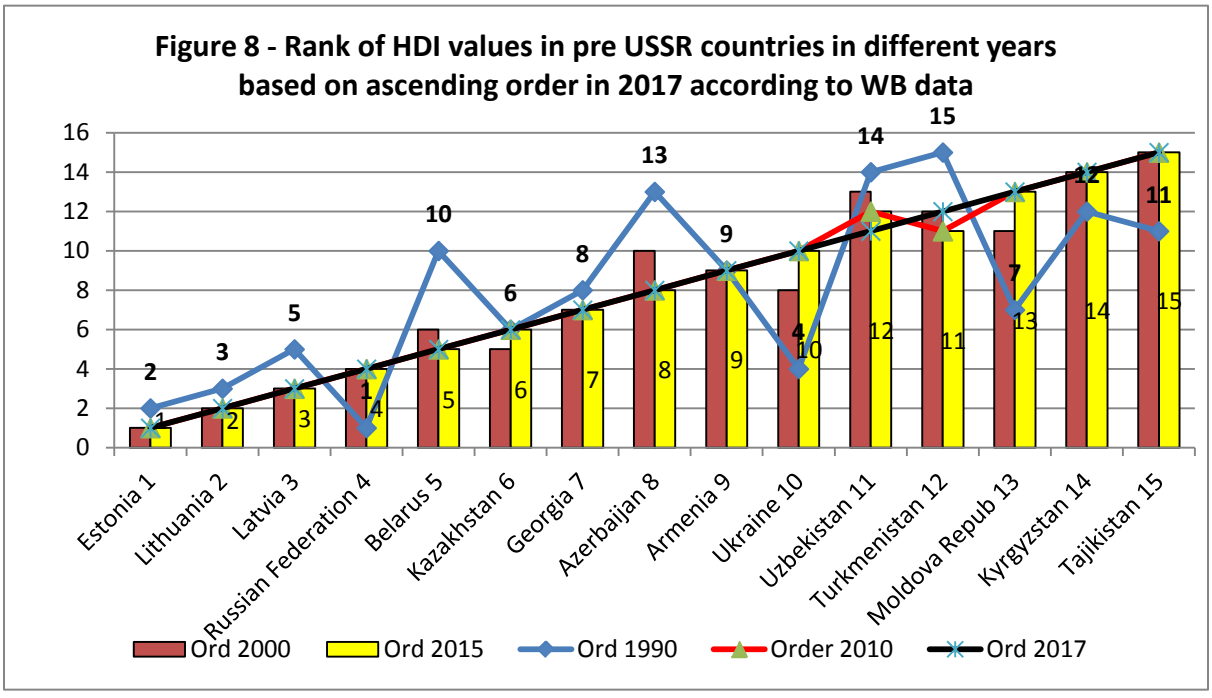


With respect to the changes in DHI ranks across the former USSR countries between 1990 and 2017 and its impact on equality levels in these years, table 7 presents the HDI values and their ranks in 1990, 2000, 2015 versus the ascending order of the ranks in 2017 as from the World Bank data. We start with the changes of ranks through these years. Figure 8 presents the graph representation of the ranks. The graph consists of two chart types (line and bar) to clarify the differences between ranks. The straight line represents the ascending order of the ranks in 2017. As observed in the chart the order of HDI values in1990 was highly different from that in 2017. 8 countries of the 15 former USSR countries their ranks were improved in the 2017 list compared to the 1990 list. The two countries with the highest improvement in rank registered by Belarus (from 10th rank in 1990 to the 5th rank in 2017 and Azerbaijan (from the 13th rank 1n 1990 to the 8th rank in 2017). However, as we always remind, the HDI values for both countries were from the estimated values in 1990. If we exclude countries with estimated values, Latvia would be the country with the highest improvement in the list (from the fifth rank in 1990 to the second rank in 2017). 5 countries registered deterioration in rank during this period. Surprisingly, three of these countries were from the top countries in 1990; these are: Russian F (from the first rank in 1990 to the fourth rank in 2017; Ukraine (from the 4th rank in 1990 to the 10th rank in 2017); and Moldova R (from the 7th rank in 1990 to the 13th rank in 2017). The countries came in the first top ranks in 2017 before Russia are: Estonia, Latonia and Latvia. Two countries kept their position in the two lists of HDI values in 1990 and 2017; Kazakhstan (the 6th rank) and Armenia (the 9th rank).

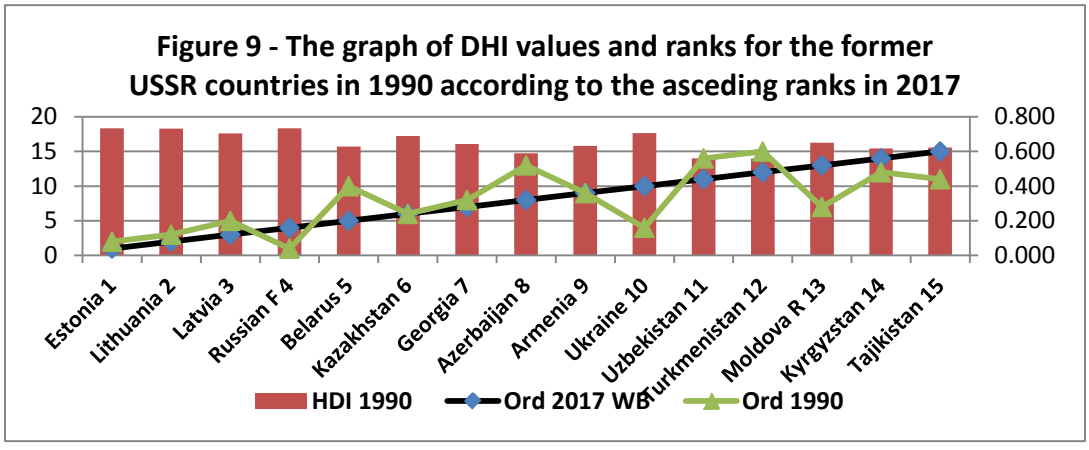
To depict the progress or retardation of ranks in HDI lists between 1990 and 2017 Table 7 shows that Estonia, Latonia, Latvia and Russia started their top first four ranks respectively from the year 2000 and conserved this position up to the year 2017. Belarus and Kazakhstan started and conserved their 5th and 6th position from 2010 to 2017. Ten countries including the above first six countries kept the same order of ranks from 2010 to 2017. For the whole countries Figure 8 shows clearly that only two countries their ranks in 2010 and 2015 differ from that in 2017; these are Uzbekistan (improved) and Turkmenistan (deteriorated). This indicates that the relative variation of HDI values in the majority of countries in the years from 2010 to 2017 was likely to be constant.

Table 7
World Bank HDI value by its rank for the former USSR countries in different years based on ascending order in 2017

State/Countr	HDI/Rank 1990		HDI/Rank 2000		HDI/Rank 2010		HDI/Rank 2015		Rank 2017
Estonia	0.733	2	0.780	1	0.845	1	0.866	1	1
Lithuania	0.732	3	0.756	2	0.824	2	0.852	2	2
Latvia	0.704	5	0.728	3	0.816	3	0.841	3	3
Russian F	0.734	1	0.720	4	0.780	4	0.813	4	4
Belarus	0.628	10	0.683	6	0.792	5	0.805	5	5
Kazakhstan	0.690	6	0.685	5	0.765	6	0.797	6	6
Georgia	0.642	8	0.673	7	0.735	7	0.771	7	7
Azerbaijan	0.589	13	0.640	10	0.740	8	0.758	8	8
Armenia	0.631	9	0.647	9	0.728	9	0.748	9	9
Ukraine	0.705	4	0.671	8	0.733	10	0.743	10	10
Uzbekistan	0.560	14	0.595	13	0.666	12	0.698	12	11
Turkmenistan	0.557	15	0.596	12	0.673	11	0.701	11	12
Moldova R	0.651	7	0.597	11	0.670	13	0.693	13	13
Kyrgyzstan	0.618	12	0.618	14	0.636	14	0.666	14	14
Tajikistan	0.623	11	0.623	15	0.634	15	0.645	15	15



Now to find out the relationship between HDI levels and improvement of ranks for the formal USSR countries through different intervals between 1990 and 2017 as from World Bank data, the figures from Figure 9 to Figure 12 show this information. In each of the four figures, the Bar type chart represents the HDI value; the straight line represents the ranks of HDI in 2017 in ascending order, and the other line represents the rank of the HDI at the beginning of each interval. At the first glance the four graphs show two observations: First, the line representing the ranks at the beginning of each interval becomes closer and closer to the straight line representing the ranks at 2017; and the ranks in the years 2010 and 2015 almost coincide with that in 2017. Second, the variation between the HDI values and the ranks at the beginning of each interval declines through the interval; and the relationship between the HDI values and their ranks, shows almost complete inverse relationship in 2015-2017 (Figure 12). This indicates that the far from dissolution date the more improvement in HD level for the countries of the high HDI value than the countries with low HDI value. To compare in this respect between the two periods of unity and dissolution, from 1990 to 1995 according to UN data and from 2015 to 2017 according to WB data, Figure 13 presents the graphs representing the period 1990-1995 from UN data, the period 1990-2017 and the period 2015-2017 from WB data. It is clear from the UN 1990-1995 graph (Figure 13.1) and the WB 2015-2017 graph (figure 13.3) that in 1990-1995 the improvement towards higher ranks was in the favor of low HDI level countries while in 2015-2017 the higher the HDI level the higher the improvement in rank. If we compare between the 1990-1995 UN graph (Figure 13.1) and the 1990-2017 WB graph (Figure 13.2) we find that they are close together although that their data are from different sources, taking into consideration that the first one represents five year interval and the second one represents 10 year interval.



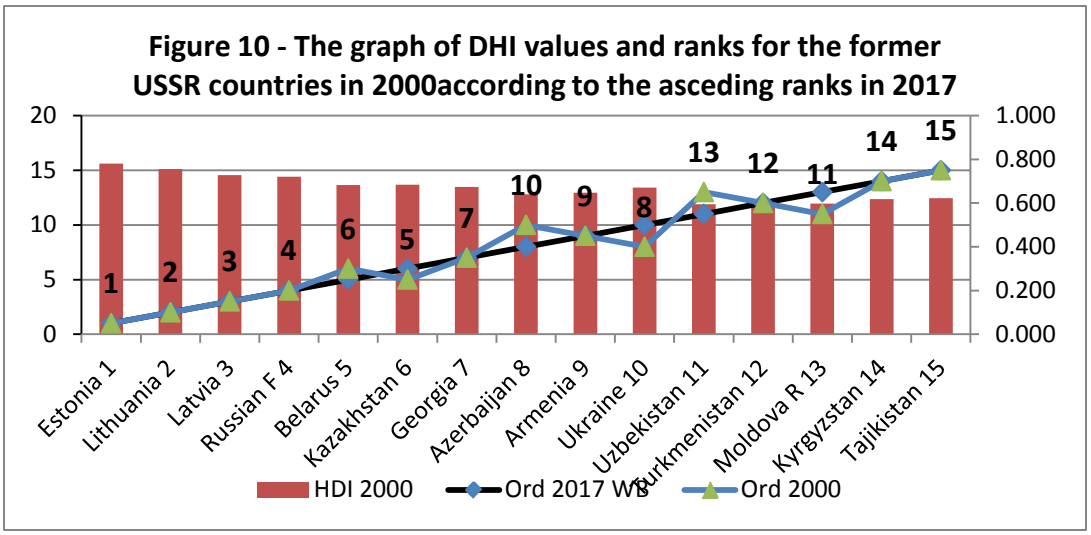


Figure 10 - The graph of DHI values and ranks for the former USSR countries in 2000according to the asceding ranks in 2017
20
15
10
5
0
1.000
0.800
0.600
0.400
0.200
0.000
1
2
3
4
6
5
7
10
9
8
13
12
11
14
15
Estonia 1
Lithuania 2
Latvia 3
Russian F 4
Belarus 5
Kazakhstan 6
Georgia 7
Azerbaijan 8
Armenia 9
Ukraine 10
Uzbekistan 11
Turkmenistan 12
Moldova R 13
Kyrgyzstan 14
Tajikistan 15
HDI 2000
Ord 2017 WB
Ord 2000

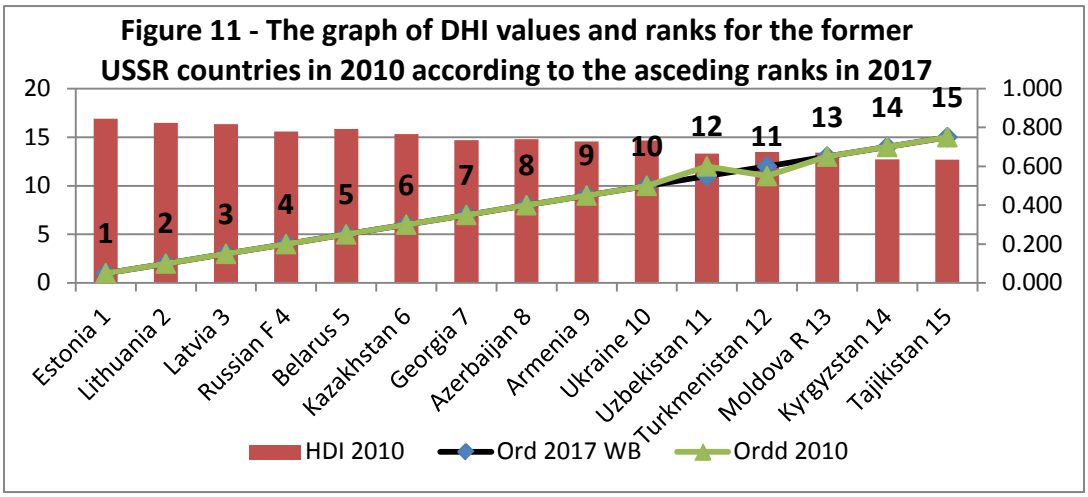


Figure 11 - The graph of DHI values and ranks for the former USSR countries in 2010 according to the asceding ranks in 2017
20
15
10
5
0
1.000
0.800
0.600
0.400
0.200
0.000
1
2
3
4
5
6
7
8
9
10
12
11
13
14
15
Estonia 1
Lithuania 2
Latvia 3
Russian F 4
Belarus 5
Kazakhstan 6
Georgia 7
Azerbaijan 8
Armenia 9
Ukraine 10
Uzbekistan 11
Turkmenistan 12
Moldova R 13
Kyrgyzstan 14
Tajikistan 15
HDI 2010
Ord 2017 WB
Ordd 2010

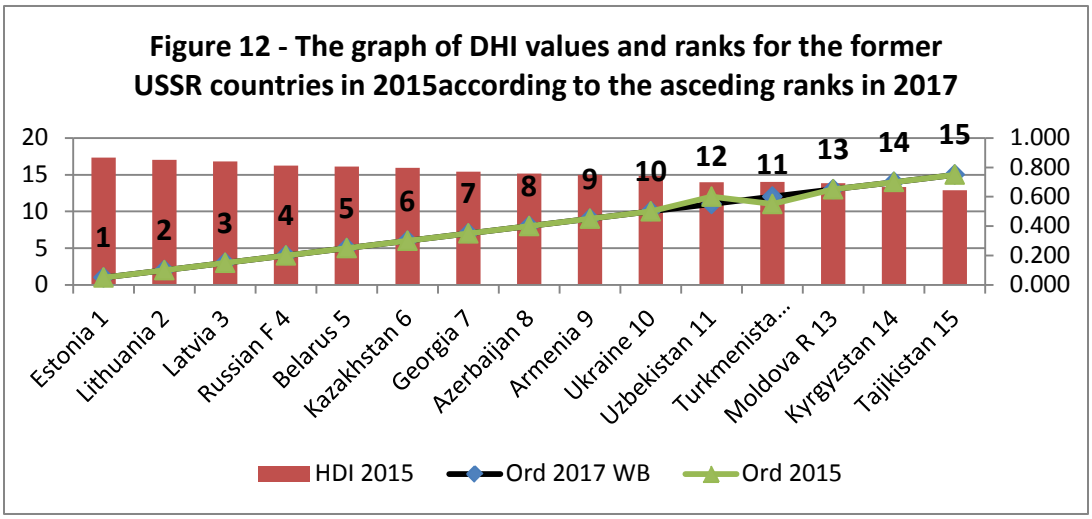
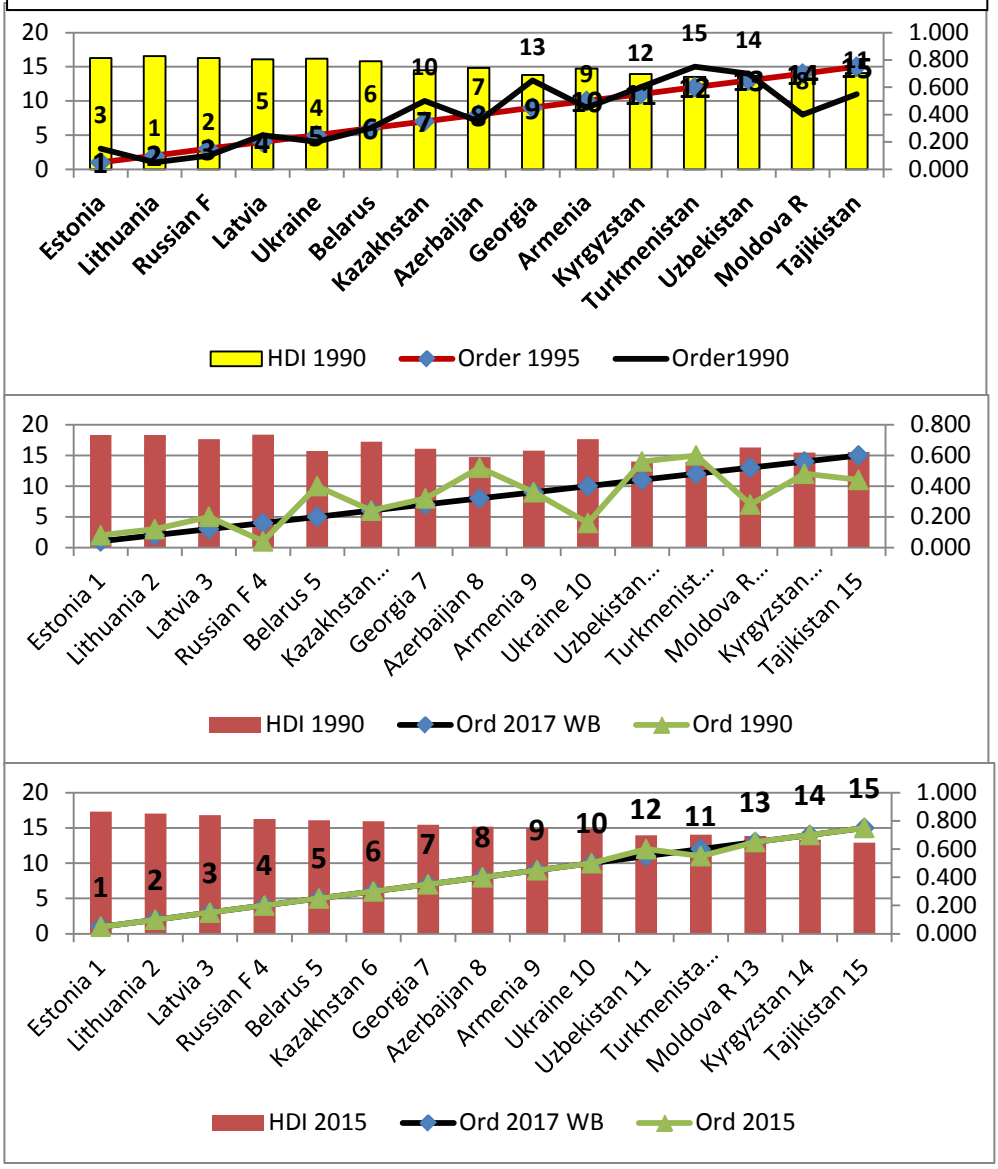


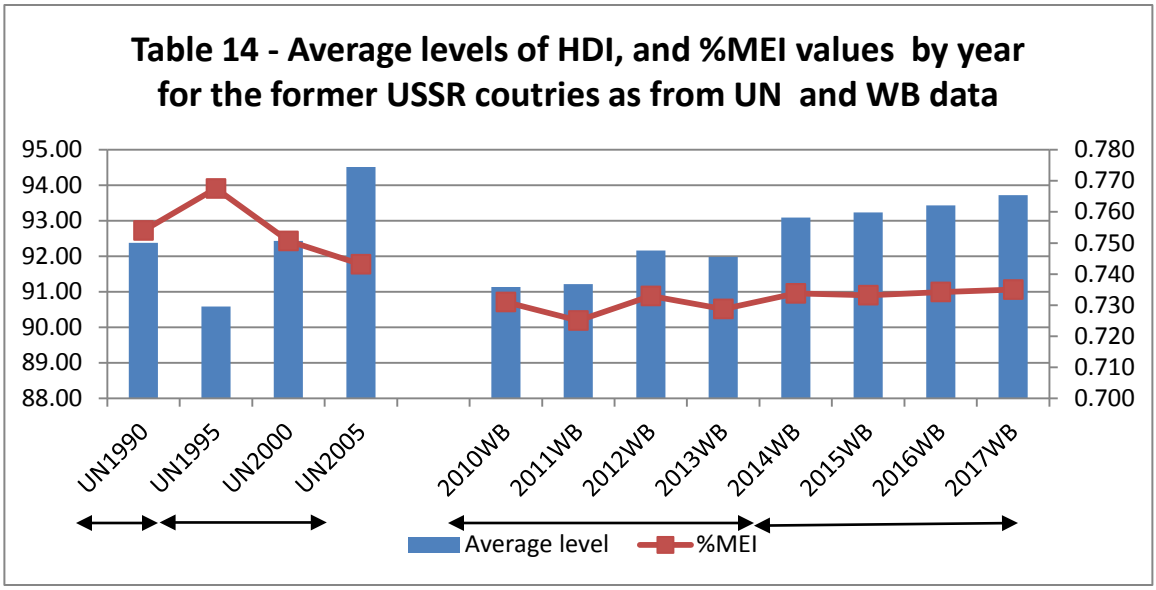
Figure 12 - The graph of DHI values and ranks for the former USSR countries in 2015according to the asceding ranks in 2017
20
15
10
5
0
1.000
0.800
0.600
0.400
0.200
0.000
1
2
3
4
5
6
7
8
9
10
12
11
13
14
15
Estonia 1
Lithuania 2
Latvia 3
Russian F 4
Belarus 5
Kazakhstan 6
Georgia 7
Azerbaijan 8
Armenia 9
Ukraine 10
Uzbekistan 11
Turkmenista...
Moldova R 13
Kyrgyzstan 14
Tajikistan 15
HDI 2015
Ord 2017 WB
Ord 2015

Figure 13 - The graph of DHI values and ranks for the former USSR countries in 1990 UN, 1990 WB, and 2015 WB according to the ascending ranks in 2017



Finally we are going to see the relationship between the levels of HDI values in former USSR countries, measured by the average value per year, and the equality level in the respective years measured by %MEI value according to UN and WB estimates. In our data we have HDI values from UN source in five year interval from 1990 to 2005; and from WB source by single year from 2010 to 2017. Figure 14 shows the charts of the average HDI and the %MEI variables. The line chart represents the %MEI values and the bar chart represents the average values of HDI. These ranges of years classify four periods and three types of equality. Two of the four periods are from the UN data and

the other two from WB data. The first period with respect to UN data represents the situation in the last year of unity and the situation shortly after dissolution. In this period as Figure 14 shows equality level in HDI increased while the value of HDI decreased. This supports our first conclusion that the higher the equality levels in HDI the lower the HDI value. This case likely happens in enforced equality cases, under united regions or local administration divisions, where benefits from equality in low HDI level units would be on the account of the high HDI level units. Although this period for the former USSR countries extended four years after dissolution date but it is likely that the momentum of the enforced equality persisted during this period. The second period for the UN data started from 1995 to 2005.This period was a transitional period for equality setting from unity situation to independency situation. As the figure indicated, in this period equality level declined whereas HDI level increased. The increase in HDI in this period was likely achieved by individual dependent endeavors. There is a gap in information on HDI between 2005 and 2010 in both sources of data; however this gap might be considered as part of the third period form WB data. The third period according to WB data starts from 2010 to 2014. As shown in the figure there was a variation in equality levels in different single years between these dates; and a variation in average HDI values for the USSR countries towards increasing trend. In this period equality could be classified as by Chance, or it is variability rather than equality according to our definitions of equality and variability concepts. The last period according to WB data was from the year 2014 to 2017. The average level of HDI in this period started to increase gradually, and %MEI values continued to change with very small differences so that it seems to move with steady pace as shown in the figure. This period could be described as a race towards the highest level of human development. In this period every country availed its maximum effort towards this target of HDI that is called a “plateau”. In this case the more approach to this plateau the lower the differences between HD level across countries though the period. Hence the type of equality in this period could be classified as inertial equality. Finally the result of this race was wined by Estonia with HDI equals 0.871 in 2017 from 0.864 in 2014. The last country in the 2017 list registered by Kyrgyzstan with HDI equals 0.672 in 2017 from 0.663 in 2014.



Summary and conclusions

- Equality level in HDI across the former USSR countries started to decline in 1995 after four years of dissolution, and then it started to increase again in 2000 after 5 years from the beginning of its decline.
- After around 20 years of dissolution equality level across the former USSR started to fluctuate up and down yearly between 2010 and 2015 and then it increased with small pace during 2015-2017
- The high level in equality around dissolution date was more likely due to the improvement of human development levels in countries with low levels of HDI values.
- In the short time after dissolution date some countries managed to utilize their independency for more improvement in human development.
- In the middle period after dissolution all countries afforded to increase their efforts to improve human development levels.
- In the last period when HDI values approaches its upper limit the pace of increase of HDI decreased for all countries as well as its variation among them.
- The far the year from dissolution date the more improvement in HDI for the countries of the high HDI level than the countries with low HDI levels.

- Although the unity of the former USSR countries was in favor of equality in human development levels across them; it was not in favor of the improvement of the levels of human development itself.
- Macro-equality type changed through the time pre and post dissolution from enforced to chance and finally to inertial equality when all levels of HDI approaches the 100% level of equality.

Appendices

Appendix 1

Human Development Index (HDI) for former USSR Countries in the years 1990, 1995, 2000 and 2005 According to United Nations Estimates

Country	Year			
	1900	1995	2000	2005
Estonia	0.813	0.792	0.829	0.860
Lithuania	0.827	0.791	0.831	0.862
Latvia	0.804	0.771	0.817	0.855
Russian Federation	0.815	0.771	0.782	0.802
Belarus	0.790	0.755	0.778	0.804
Kazakhstan	0.724	0.738	0.794	NA
Georgia	NA	NA	NA	0.754
Azerbaijan	NA	NA	NA	0.746
Armenia	0.737	0.701	0.738	0.775
Ukraine	0.809	0.756	0.761	0.788
Uzbekistan	0.683	0.691	0.702	NA
Turkmenistan	NA	NA	0.713	NA
Moldova (Republic of)	0.740	0.684	0.683	0.708
Tajikistan	0.703	0.638	0.640	0.673
Kyrgyzstan	NA	NA	0.696	NA

Appendix 2-A

Human Development Index (HDI) for former USSR Countries in the years 1990, 2000, and 2010 According to Word Bank estimates

Country	Year		
	1900	2000	2010
Estonia	0.733	0.780	0.845
Lithuania	0.732	0.756	0.824
Latvia	0.704	0.728	0.816
Russian Federation	0.734	0.720	0.780
Belarus	NA	0.683	0.792
Kazakhstan	0.690	0.685	0.765
Georgia	NA	0.673	0.735
Azerbaijan	NA	0.640	0.740
Armenia	0.631	0.647	0.728
Ukraine	0.705	0.671	0.733
Uzbekistan	NA	0.595	0.666
Turkmenistan	NA	0.596	0.673
Moldova (Republic of)	0.651	0.597	0.670
Tajikistan	0.623	0.550	0.634
Kyrgyzstan	0.618	0.594	0.636

Appendix 2-B
Human Development Index (HDI) for former USSR Countries by single years from 2010 to 2017 According to World Bank Estimates

Country	Year							
	2010	2011	2012	2013	2014	2015	2016	2017
Estonia	0.845	0.849	0.859	0.859	0.864	0.866	0.868	0.871
Lithuania	0.824	0.831	0.831	0.837	0.851	0.852	0.855	0.858
Latvia	0.816	0.812	0.824	0.816	0.838	0.841	0.844	0.847
Russian Federation	0.780	0.79	0.798	0.797	0.807	0.813	0.815	0.816
Belarus	0.792	0.793	0.803	0.796	0.807	0.805	0.805	0.808
Kazakhstan	0.765	0.772	0.781	0.785	0.793	0.797	0.797	0.800
Georgia	0.735	0.74	0.750	0.750	0.765	0.771	0.776	0.780
Azerbaijan	0.740	0.742	0.745	0.749	0.758	0.758	0.757	0.757
Armenia	0.728	0.723	0.737	0.731	0.745	0.748	0.749	0.755
Ukraine	0.733	0.738	0.743	0.746	0.748	0.743	0.746	0.751
Uzbekistan	0.666	0.661	0.683	0.672	0.695	0.698	0.703	0.710
Turkmenistan	0.673	0.671	0.686	0.682	0.697	0.701	0.705	0.706
Moldova (Republic of)	0.670	0.679	0.684	0.69	0.696	0.693	0.697	0.700
Tajikistan	0.634	0.612	0.642	0.621	0.645	0.645	0.647	0.650
Kyrgyzstan	0.636	0.639	0.649	0.652	0.663	0.666	0.669	0.672

Appendix 3
Methods of development of Macro-Equality Index and Macro-Equality Standardized Correlation Coefficient

A. The Macro-Equality Index:

It is well known that the standard deviation statistic measures variability. However, this statistical measure lacks validity of comparability. It cannot compare between dispersion levels of different variables unless the means of these variables are the same. To solve this problem we found that when the percentages of values of different variables across a set of units are considered the means of these percentages are equal. Accordingly, if the percentages of values of a variable in different sets of units are considered the statistical means of these percentages are equal for all sets as far as the total numbers of units in these sets are equal. We call this mean "the standardized mean (SM)", and the standard deviation of these percentages "the standardized standard deviation (SSD)". Hence the macro-equality index (MEI) is defined by the following equation:

[MEI = SM – SSD] --------- (1)

The lower limit of the index equals zero when the SM = SSD, and the upper limit equals SM when SSD=0. Therefore, we can compare between equality levels of different variables across subdivision areas of a region, or of a variable across subdivision areas of different regions with equal numbers of subdivision units. To compare between equality levels of variables for regions with different number of subdivision areas the percent macro-equality index (%MEI) could be used.

B. Macro-Equality Standardized Correlation Coefficient:

The correlation coefficient statistic (CC) could be used to measure the equality power of a variable between two points of time, and accordingly to develop a mechanism to monitor strategies of equality control. This could be done by calculating the correlation coefficient of the relationship between

(the values of a variable referred to a base year time) and (the differences between these values and values of the same variable referred to a future point of time). We call this correlation coefficient “the Macro Equality Correlation Coefficient (MCC)”. A negative ECC in this respect indicates a positive equality development power during the two points of time. For a complete equality the MCC value of this relationship would be -1; In this case the value of the tested variable would be the same for all units at the target time. For a complete inequality the MCC value of the relationship would be +1. Accordingly, a macro-equality line could be defined to be the case when the MCC value equals zero. This zero equality power line is a theoretical point assigns to a specific MEI value which needs more exercises to detect it.

Appendix 4-A
Estimation of HDI missing data From UN list and WB list by Extrapolation and Interpolation

This method is used when there are two sources of the same variable in series of years include identical years in the two sources

Data

- WB HDI estimates in the years 1990, 2000 and 2010; and by single year from 2010 up to 2017.
- UN HDI estimates in 1990, 1995, 2000 and 2005.

Years with missing data:

- For WB data: the year 1990
- For UN data: all years from 1990 to 2005

Method

- For WB data: The missing values of HDI in 1990 estimated by backward extrapolation from the HDI values in 2000 and 2010 for the same country.
- For UN data: As all years include missing values; the following procedure was followed:
    - For the UN 1990 missing values: the WB 1990 and UN 1990 HDI values were sorted in ascending order of the WB values.
    - The missing value of HDI for a country in the UN 1990 list was estimated from the percent change of HDI from the previous country in the WB 1990 list to country in WB list online with the concerned country in UN 1990 list.
    - The missing values of HDI in UN 2000 list were estimated by the same pervious steps taking the WB 2000 values as the reference year.
    - The missing values of HDI in 1995 list were estimated by interpolation from the UN 1990 and UN 2000 list for the same country.

a. The missing values of HDI in 2005 list were estimated by forward extrapolation from the UN 1990 and UN 1995 list for the same country.

Appendix 4-B
Evaluation of indicator values from different sources

Adjustment and Evaluation Theory:

"If there are different lists of data for the same variable in the same year from different sources, then the MEI value should be the same for all lists"

The evaluation of international indicators from different sources would be done on the basis of the adjustment and evaluation theory as follows:

- The method would be applied only for the same variable in the same year within the different sources' lists.
- In all lists there should be a list without missing data, we call this the reference list.
- The values of SM, SSD and hence MEI would be calculated for all lists.
- The lower the difference between the MEI value of the respective list and the reference list, the more likely the estimated values of the respective list would be reliable. However, we have not yet specified a cutting difference between the MEI values of the two lists to evaluate the limit of accuracy of estimates.