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Time Distance Comparisons of Macro Indicators of Wellbeing

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Time Distance Comparisons of Macro Indicators of Wellbeing

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Abstract

The present state-of-the-art of comparative analysis does not realise that, in addition to static comparison, there exists in principle a theoretically equally universal measure of difference (distance) in time, i.e. a generic statistical measure S-time-distance showing the distance in time when a given level of the variable is attained by the two compared time series. Expressed in time units it is an excellent presentation tool easily understood by policy makers, managers, media and general public.

In the empirical part the S-time-distances were estimated for 160 countries for GDP per capita in 2003 and for 190 countries for female life expectancy and for 192 countries for infant mortality in 2005 against the long-term series for Sweden as a benchmark. They showed an added dimension of the disparity in the world: one half of the countries were lagging Sweden by more than 70 years, 36 countries even for more than 160 years. For infant mortality the median value was 57 years and for female life expectancy 53 years. Comparisons between EU27, USA and China illustrate the theoretical points that the degree of disparity may be very different in static terms and in time distance. This conclusion was very strong in the analysis of the Human Development Index which raises a set of questions rather than presenting answers: how to treat and interpret inter-temporal changes of composite indicators?

1. Introduction

The paper is focused on the inter-temporal aspect of measuring wellbeing and societal progress. In the 2004 IARIW Conference there was a coincidence that two papers in the plenary sessions on measuring and interpreting global inequality and poverty raised the same problem of the unsatisfactory situation that at the empirical level the one-sided reliance on relative measures is almost unconditional and both recommended that they should be complemented by other dimensions.

Atkinson and Brandolini (2004) emphasised that they have never seen official publications reporting estimates of absolute inequality. In their paper 'Global world inequality: absolute, relative or intermediary?' - they put the emphasis on a broader choice of static measures. Sicherl (2004), on the other hand, in the paper 'Time distance: a missing link in comparative analysis'- discussed the time distance concept and its role in measuring the temporal aspect of disparity. It was underlined that in the dynamic world of today it is not satisfactory to rely only on static measures of disparity. The arguments for extension in several directions to a broader framework in theory and especially in empirical and policy work are well established; it has to happen sooner or later.

The collection and dissemination of quality data on selected indicators is only a necessary but far from sufficient condition to reach the goals in the chain of the OECD Global Project on Measuring Progress: Statistics, Knowledge, and Policy. Equally important are the concepts and tools of analysis that systematise and transform information into perceptions relevant for decision-making. These perceptions and the decisions, behaviour and actions undertaken are also influenced by the quantitative indicators and **measures used in the semantics of discussing the issues, in setting the targets and in following their implementation**. The better the analytical framework the greater the information content provided to experts, decision makers, media and general public.

Methodology: S-time-distance as a generic statistical measure complementing existing measures

Comparing across many indicators and fields of concern is the essence of quantitative work in forming perceptions assessing the overall "position" and "progress". At the same level of generality as two most widely used measures (static difference and growth rate) there exists a companion generic statistical measure S-time-distance as a special category of time distances that is defined by the level of the variable. In graphical terms, the usual way is to compare the time series in the **vertical dimension**, **i.e. for a given point in time**. The S-time-distance approach uses an additional perspective; it compares the respective time series in the **horizontal dimension**, **i.e. for a given level of the variable**.

Comparing two points in a time series database entails three elements of information: (i) the respective level of the variable, (ii) to which unit it belongs, and (iii) at what time it happened. There are two obvious generic directions of comparison: by time and by level (Sicherl, 2004, 2007a). In brief, statistical measure S-time-distance measures the distance (proximity) in time between the points in time when the two series compared reach a specified level of the indicator X. The observed distance in time (the number of years, quarters, months, etc.) for given level of the indicator is used as a temporal measure of disparity between the two series, in the same way that the observed difference (absolute or relative) at a given point in time is used as a static measure of disparity.

The new approach provides from existing database additional information content, without replacing the existing views. If we choose to interchange in the database the roles of the level of the variable and time, a given level of the variable becomes a descriptor or identifier and time becomes a numeraire in which certain distances between the compared units and time series can be expressed and measured. The present state-of-the-art neglects this additional information that has been always available in time series databases as "a hidden dimension" and thus leads to an information loss. The result of this new perspective is a time matrix with new information from which two new generic measures can be derived. A brief presentation of the definitions from Sicherl (2004, 2006, and 2007a) is provided here.

Firstly, for a given level of the indicator X_L, $X_L = X_i(t_i) = X_j(t_j)$, **S-time-distance** is the time difference between points in time when unit (i) and unit (j) reached the level X_L

$$S_{ij}(X_L) = \Delta T(X_L) = t_i(X_L) - t_j(X_L) \qquad (1)$$

where T is determined by X_L. In special cases T can be a function of the level of the indicator X_L, while in general it may take more values when the same level is attained at more points in time, i.e. it is a vector which can in addition to the level X_L be related to time ($T_1, T_2, \ldots T_n$).

The sign of the time distance comparing two units is important to distinguish whether we are dealing with time lead (-) or time lag (+) (in a statistical sense and not as a functional relationship)

$$S_{ij}(X_L) = -S_{ji}(X_L). \qquad (2)$$

S-time-distance is calculated from the original values of the variable (with some possible interpolation and extrapolation) without referring to any other information than levels of the variable and time subscripts. This is a confirmation of the statement that time distance provides an additional (n+1) dimension of description of the state of a multidimensional space of n variables ($X_{i,}$ i=1, ….n).

Secondly, subtracting the respective times in the time matrix for consecutive levels of the variable for each column **vertically** derives the second suggested measure **S-time-step**. These vertical differences can be labeled as time steps and represent an alternative description to the growth rate measure. The concept of S-time-step measures the growth characteristics of a series, using the inverse relation to the conventional $\Delta X/\Delta t$ or growth rate metrics. S-time-step as a measure expressed in units of time is defined as

$$S_i(\Delta X_L) = (t_{XL+\Delta X} - t_{XL})/\Delta X. \qquad (3)$$

S-time-step is obtained by simple subtraction of consecutive times in columns in the time matrix if ΔX_L is kept constant.

These two novel statistical measures will be applied to some macroeconomic indicators of wellbeing to illustrate the new insights that can be added to their analysis thus complementing the results of the present state-of–the-art.

3. World inequality in the time distance perspective

GDP per capita

This section will present the S-time-distance estimates for 160 countries for GDP per capita based on time series data by Angus Maddison (2003). Recent data for these countries in 2003 will be compared with the time series data for Sweden for the period 1820-2003. GDP per capita is most widely used indicator of level of income and of income disparities in the world. Sweden as one of the most developed countries by GDP per capita is selected as a benchmark for the reason that it has good long-term series also on life expectancy and infant mortality and thus the results on the income disparities can be compared also with these indicators. Additionally, this will provide also a background for the analysis of the Human Development Index (HDI) below as an example of a composite indicator of wellbeing.

Figure 1 provides a new perception of the degree of income disparity through the time distance lens. This additional perspective to absolute or relative measures of disparity for a given country or to aggregate measures of disparity like Gini coefficient or Theil index can be derived from the existing data. Already a quick glance at the Figure 1 indicates three important contributions to the analysis: 1. the time distance measure of disparity is intuitively understood by everyone; 2. expressed in units of time S-time-distance can be comparable across variables, fields of concern, and units of comparison; 3. earlier results by other methods are left unchanged, but new conclusions may be reached due to an added dimension of analysis.

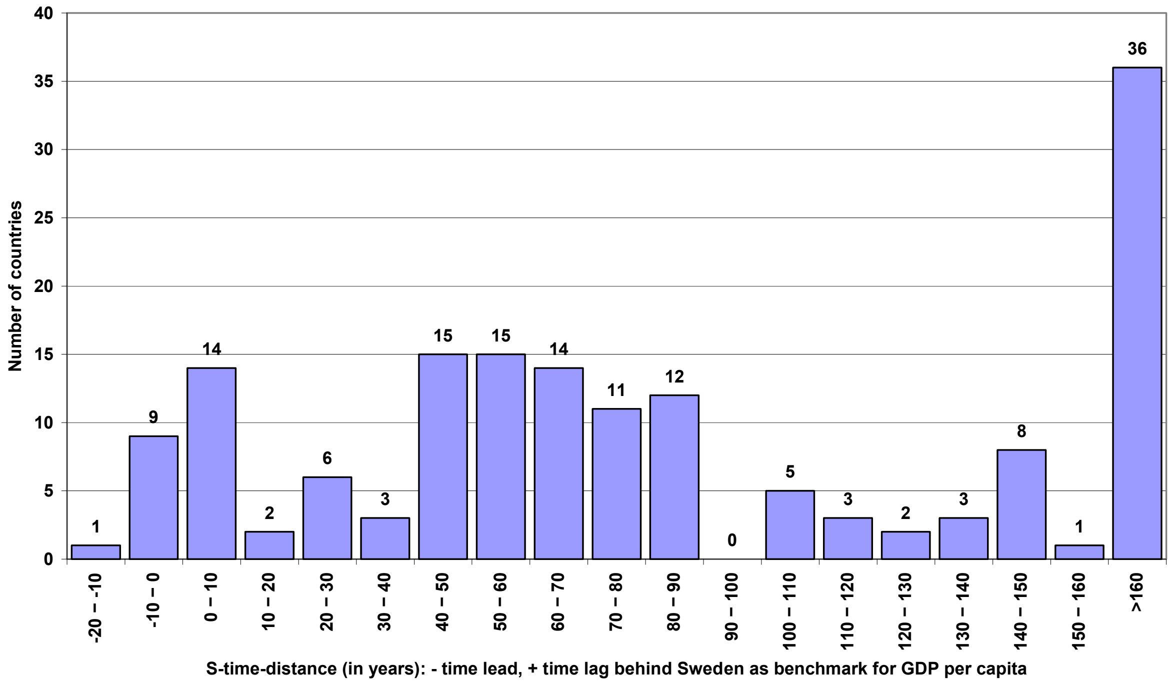

Figure 1. Frequency distribution of time lag for 160 countries for 2003 for GDP per capita compared to the long term trend for Sweden as benchmark

There are two most striking conclusions from the frequency distribution of S-time-distances. Firstly, the median of the distribution amounts to 70 years, which means that more than half of the 160 analysed countries show a time distance gap behind Sweden of more than 70 years. Secondly, for 36 countries the time distance behind Sweden is more than 160 years.

This is a novel viewpoint of the magnitude of the income disparity measured by the GDP per capita as one of the macroeconomic indicators of wellbeing that is easy to understand. It is not meant to replace e.g. the analysis of Gini coefficient or other relative static measures; it is another view from the same data. We need analysis of both perspectives on the data to reach a more balanced and relevant conclusions.

Such broader examination of different perspectives can help to build better perceptions of the situations and at the same time might be useful for raising the questions whether the existing concepts and databases are in line with the subjective perceptions of people and decision makers. Let me use both above mentioned examples. The time distance analysis shows that for the median country the value of GDP per capita in 2003 was achieved in Sweden already in 1933; for the last group of 36 countries in Figure 1 before 1883. Looking in percentage terms, the median country had in 2003 only 17 percent of the Swedish income per capita, the 36 countries only 1-5 percent of it. Whether we are looking at S-time-distance gap or at the percentage gap, the data used show huge degree of disparity.

International comparisons are subject to problems of accuracy, coverage and comparability of data, and the conclusions should be approached with the necessary caution. Due to the lack of space we shall not elaborate on the combination of various statistical measures in describing and assessing the trends in the degree of global inequality. It was established that from existing datasets (like Maddison, 2003) a time series of a novel statistical measure with evident interpretability can be developed, also at the country and regional levels.

Figure 2 will briefly illustrate the example at the level of the world regions from the world average which is based on Sicherl (2004) at the 2004 IARIW conference which should be consulted for details, including Maddison (2003) for original data on GDP per capita and on assumptions used at arriving to the estimates. Maddison breaks the analysed countries into seven regions (the region 'Western Offshoots' is composed of USA, Canada, Australia and New Zealand).

For a more appropriate understanding of the interpretation of the time distance measure there is an important distinction between backward looking (ex post) and forward looking (ex ante) time distances. They relate to different periods, past and future. The first belongs to the domain of statistical measures based on known facts; the second is important for describing the time distance outcomes of the results of alternative policy scenarios for the future. The estimates are ex-post values of S-time-distance. S-time-distance of 30 years does not at all mean that e.g. Asia will need 30 years to reach the world average income. The value of this special category of time distance is simply a statistical fact that the 2001 value for Asia was attained by the world average 30 years earlier, i.e. in 1971. What will be the time needed for Asia to reach the world average income will depend on the future growth rates and this will be discussed below.

The greatest improvement after World War II was achieved in Asia, which was in 1950 lagging the world average even more than Africa. By 2001 the time lag was reduced to 30 years. Eastern Europe dropped at the beginning of transition in 1990 from a position above the world average to that below the average and is by this data set positioned approximately equal with Latin America, at a level very similar to the world average. The former Soviet Union has from a time lead of about 25 years against the world average in 1993 started a great decline, which has been reversed. Western Europe, on the other hand, shows a lead of about 45 years against the world average (Sicherl, 2004).

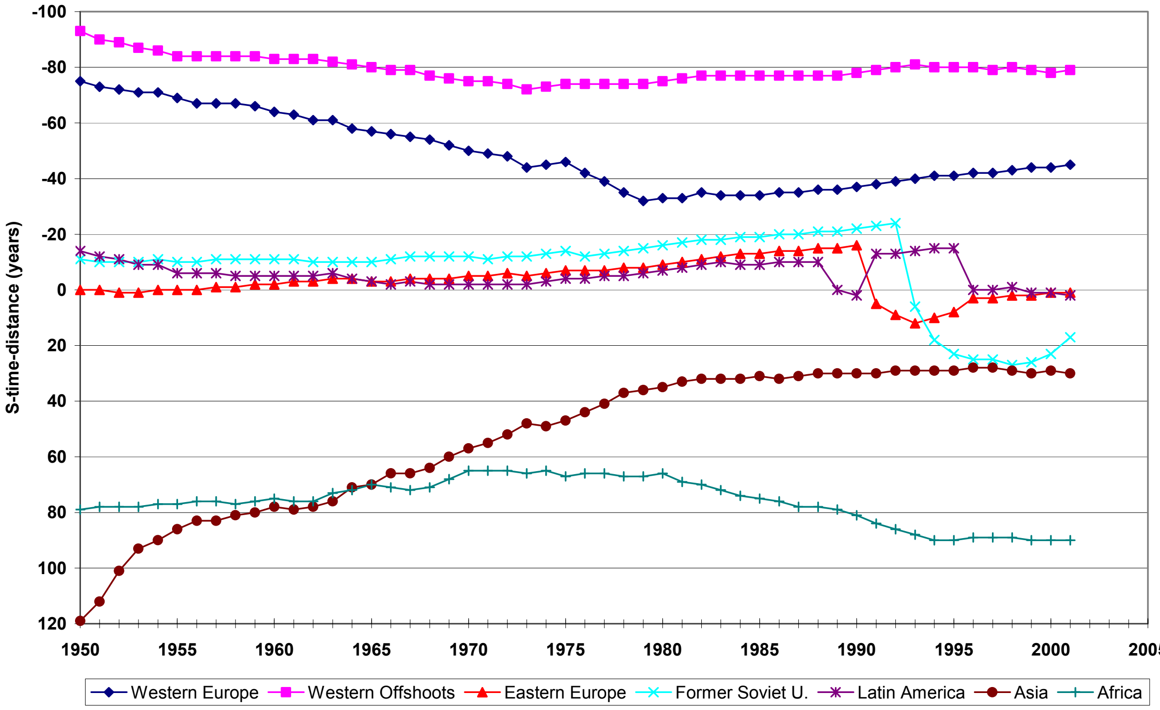

Figure 2. S-time-distance for GDP per capita from the world average in years (- time lead, + time lag)

In the period of high growth rates (1950-1973) there was a considerable decline in the dimension of inequality measured by S-time-distance for several regions. The time lead of 'Western Offshoots' declined from 93 years to 72 years, for Western Europe from 75 years to 44 years. The time lag for Asia declined from 119 years to 48 years and that of Africa from 79 years to 66 years. These were very considerable trends related to the two most advanced and the two least developed world regions.

In the period 1973-2001 there were fluctuation but not substantial changes in time distances for the two most developed world regions with respect to the world average. Contrary to that, in the three regions closer to the world average there were drastic breaks in the trend for the former Soviet Union and for Eastern Europe, and considerable fluctuation in Latin America. The two least developed regions show diametrically opposite developments. The time lag for Africa increased from 66 years in 1973 to 90 years in 2001, while that of Asia decreased from 48 to 30 years.

These results from Sicherl (2004) are describing one dimension of global inequality over these two periods indicating that the time distance approach usefully complements existing measures and perceptions. The analytical conclusion that higher magnitudes of growth rates of the indicator lead, ceteris paribus, to smaller time distances, and vice versa, is important in explaining past developments and in preparing policy recommendations.

<u>It is possible to change the time lag rapidly and sensitivity analysis for different data sources</u>

The above analysis can be extended to newer data and more details for three compared units: EU27, USA and China prepared for EUROCHAMBRES (Sicherl, 2008a).

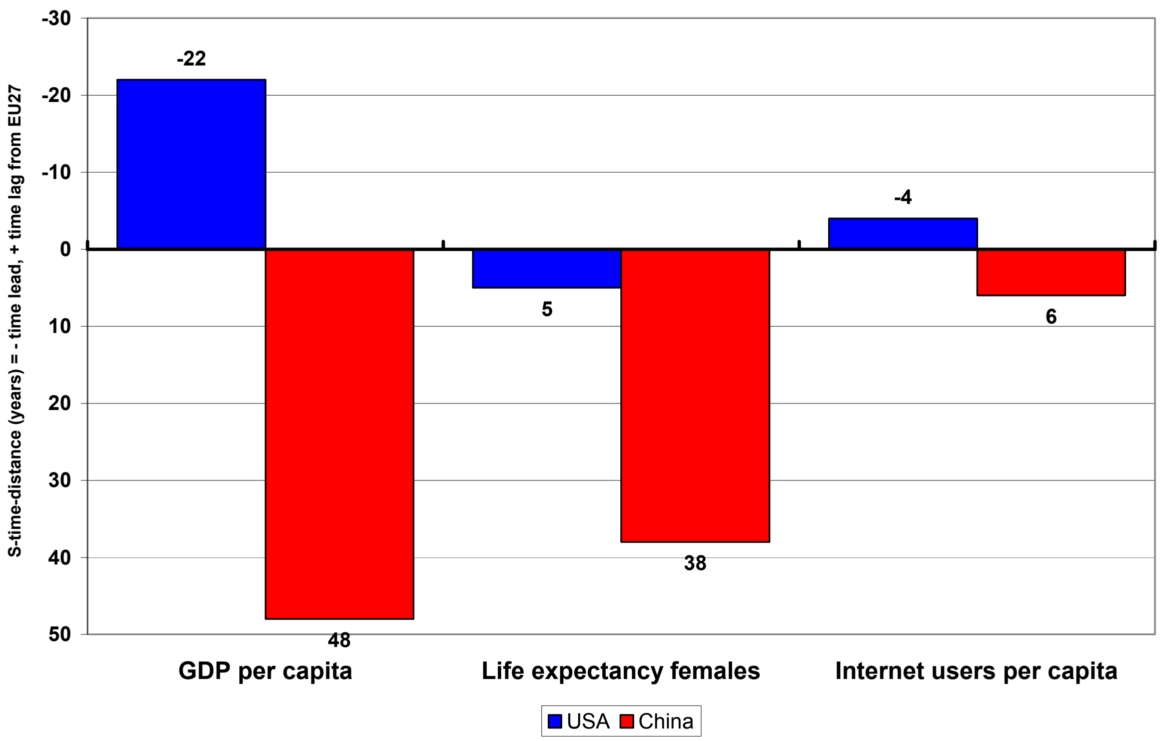

Figure 3. S-time-distance in years between EU27, USA and China for selected indicators around 2007 (EU27=base)

Figure 3 shows the time distance results for three selected indicators across different fields, economic, social and information society compared to the EU27 levels. USA was ahead of EU27 for 22 years for GDP per capita for this macroeconomic indicator, 5 years behind for the social indicator female life expectancy, and 4 years ahead for internet users per capita. For GDP per capita China lags 48 years behind the EU and about 70 years behind the US; for internet users per capita China was in 2006 according to ITU data 6 years behind the EU and 10 years behind the US.

The comparisons between USA and China for GDP per capita and internet users per capita illustrates the theoretical points that the degree of disparity may be very different in static terms and in time distance, which leads to new conclusions and semantics important for policy considerations. Using IMF data the static ratio between USA and China for GDP per capita was in 2007 4.9, for internet users per capita according to ITU data was 6.7 for 2006. Using only ratio as a static relative measure one may be satisfied with the conclusion that the disparity in the internet users per capita was greater than for the GDP per capita. S-time-distance shows a different perspective, the time distance was for GDP per capita about 70 years and for internet users per capita about 10 years.

In a dynamic world it is not adequate to rely on static measures of disparity alone. They take into account only differences in the growth rates between the units and neglect the effects of the absolute magnitudes of the growth rates. In this respect time distance plays in the analysis of disparities an important role, quite distinct from that of static measures. Another example will show that notwithstanding the current significant gap in GDP per capita with EU and US, China's pace of growth is cutting this time-distance dramatically.

Figure 4 shows the calculations of 'what if' scenarios when would China reach the present 2007 levels of GDP per capita of USA and EU27. Using IMF starting data for 2007, if

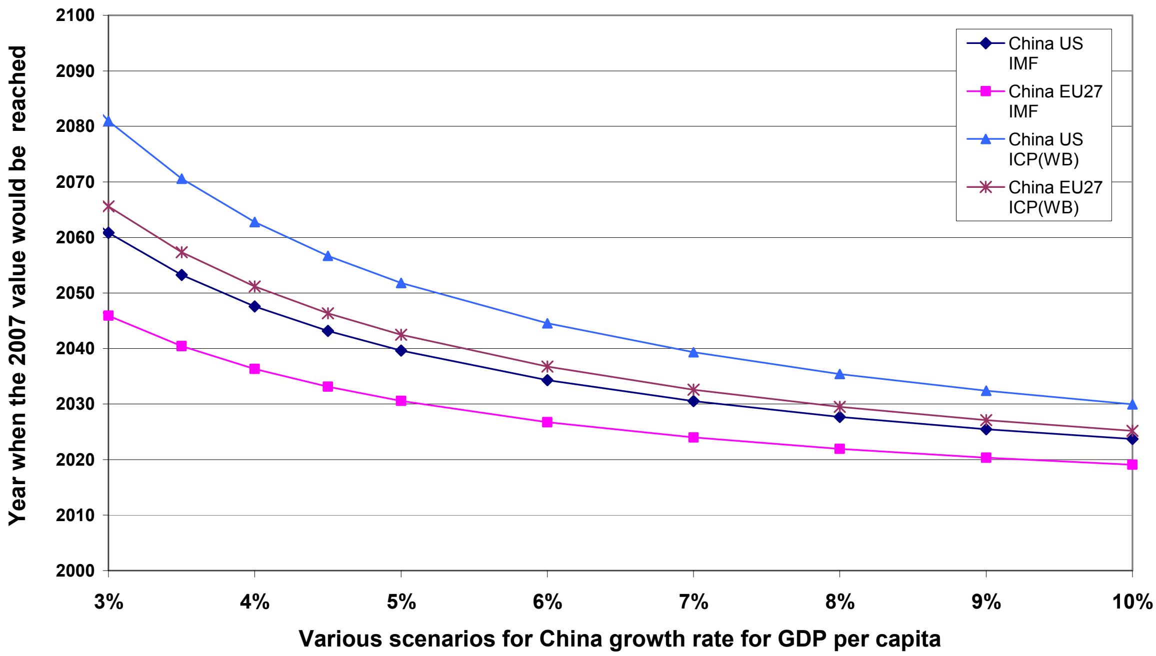

Figure 4. Estimated year in which the present value of the GDP per capita for EU27 or USA would be reached by China for various scenarios

China's GDP per capita will continue growing at about 10% per year in the coming years, this would bring China to catch up with the 2007 EU level in 12 years and in 17 years with the 2007 US level. Even with 5% growth, the present EU level could be reached by 2031, which means that in that year the S-time-distance for GDP per capita between EU27 and China would be reduced to 24 years from 48 years in 2007. It would be shorter for higher growth rate of GDP per capita for China and it depends only on China's growth rate.

However, the above example should not be generalized as an overall tendency for rapidly decreasing time distances for GDP per capita for two reasons. Many countries are far away from the dynamic growth of China used in the example here; also higher prices of energy, food and raw materials might be adversely affecting future growth rates.

For the IARIW even more relevant factor influencing the numerical estimates above is the problems of accuracy, coverage and comparability of the available data on GDP per capita. The 2005 results of the International Comparison Program (ICP), published by the World Bank (2007), show very different estimates for GDP than those by IMF and Maddison. They show that for 2005 values of GDP were for China and India about 50 percent lower (the respective figures are presented in the Annex Table A1). This is a huge difference which would greatly increase the income disparities in the world if correct. It is important that this wide discrepancy is settled.

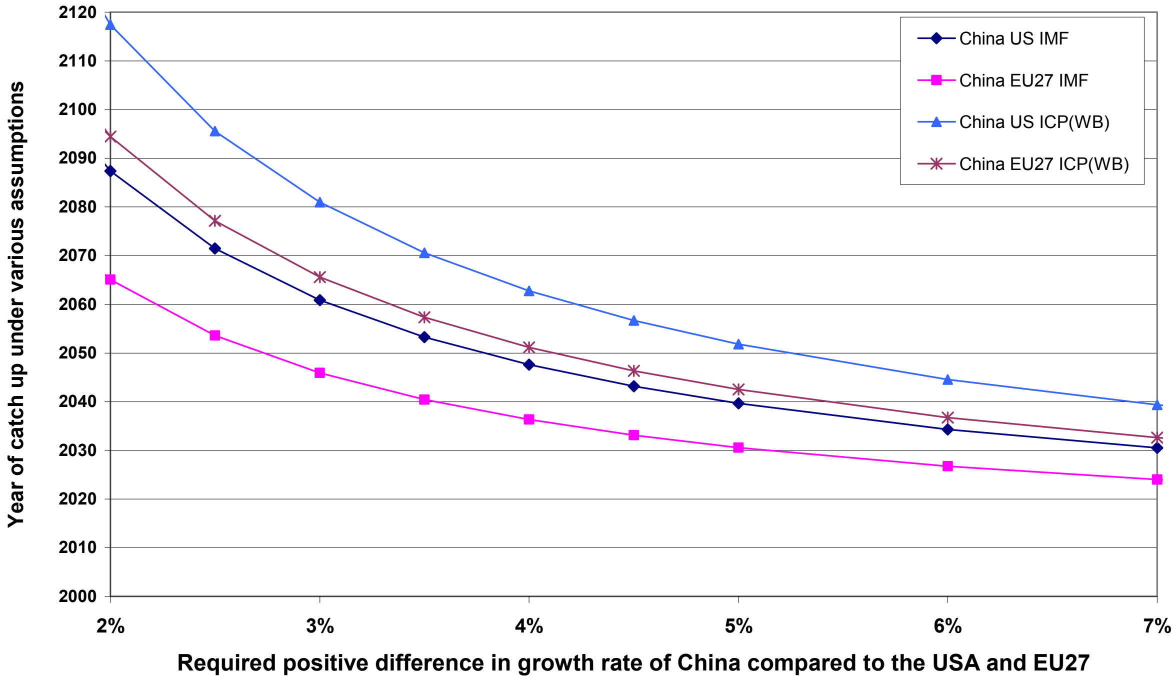

Figure 5. Year in which China would catch up with the USA or EU27 GDP per capita under various assumptions

In this paper which is based on data from Angus Maddison and IMF we simply use this disparity in terms of data as a sensitivity analysis exercise and a double calculation is run for both EU-China and US-China comparisons, on the basis of differing sets of data from the IMF and the study of the International Comparison Program (ICP) published by the World Bank. The static disparity between USA and EU27 would be increased in 2007 by about 80 percent and yet because of very high growth rate in China the present GDP per capita of USA and EU27 would be reached only 6 years later (10% growth) and 12 years later (5% growth).

Figure 5 shows the respective 'what if' scenarios for catching up, i.e. full equalisation with the USA or EU27 GDP per capita. While the time to reach the present values of GDP per capita in Figure 4 depended only on the starting position and on the growth rate for China, the full equalization depends on the starting position and on the difference between the respective growth rates of the indicator for the lower and the higher unit[1].

In an optimistic scenario if Chinese GDP per capita growth will outpace European growth for about 7% in the coming years, China would eventually catch up with the EU27 in 17 to 26 years, and in 24 to 32 years with the USA[2]. Even with a much smaller difference in growth between China and the EU, for example of 3%, China would catch up with the EU27 between 2046 and 2066.

Infant mortality rate

The analysis of the long-term viewpoint for income disparity will be followed for life expectancy and infant mortality rate over many countries. This will offer both the possibility to examine the time distance perspective in each of these three important domains as well as a comparison of conclusions across the three indicators.

Infant mortality rate is interesting also from the point of view that in contrast with the complex aggregation, weighting and comparability issues involved with the GDP data series the indicator value is very transparent and easy to understand. While the coverage and accuracy of the administrative records in some countries may be a problem, it cannot happen that e.g. a different choice of price indices would change substantially the results as seen in the previous section. Thus it is of interest to look at the time distance estimates of the world disparity for infant mortality rate and compare it with that for GDP per capita, though they are relating to different topics.

We follow the same procedure in using Sweden as benchmark. The long-term series for Sweden from Mitchell (2003) as 3-years moving average are compared with the UNICEF estimates for 2005 for 192 countries. Figure 6 presents the frequency distribution of countries with respect to S-time-distance from the historical development in Sweden. The modus of the distribution is in the group 51-60 years, the median value is 57 years. In comparison with the respective distribution of countries for GDP per capita there is no huge tail of the 36 countries which showed the time lag behind Sweden of more than 160 years. Nevertheless, the disparities are still very large. A time distance analysis of the implementation of the UN Millennium Development Goals[3] (MDG) showed that Developing Regions were in 2004 at

[1] The formula for the time needed to achieve a complete equalisation is generally known (see e.g. Sicherl, 1973, p.565):

$$t_e = \ln a(0)/(r_2 - r_1),$$

where a(0) is a ratio for the USA and EU27 (China=1) in the starting period, while r_2 and r_1 are average growth rates for China and respectively for EU27 and the USA in the future. The time needed represents only a result of a simple algebraic manipulation calculating when the values for the two units shall equalise under the presumed conditions.

[2] Depending on IMF or ICP(WB) starting data.

[3] Monitoring and evaluation of the degree of implementation of policy targets are indispensable phases of the policy circle. The interpretation of the deviation of actual development from the line to target with S-time-distance measure is straightforward and intuitively understandable; it deals with lead or lag against the line to their own target. It is like tracking the actual arrivals in comparison with the train or bus timetable. Applications to monitoring Lisbon and MDG targets can be found on http://www.gaptimer.eu/monitoring/ . Free GAPTIMER monitoring tool for calculation and graphing of S-time-distance deviations from the line to target is available.

least 7 years behind the line to the 2015 MDG target for infant mortality rate (Sicherl, 2007b). It is obvious that infant mortality is still a very imperative issue on the global scene.

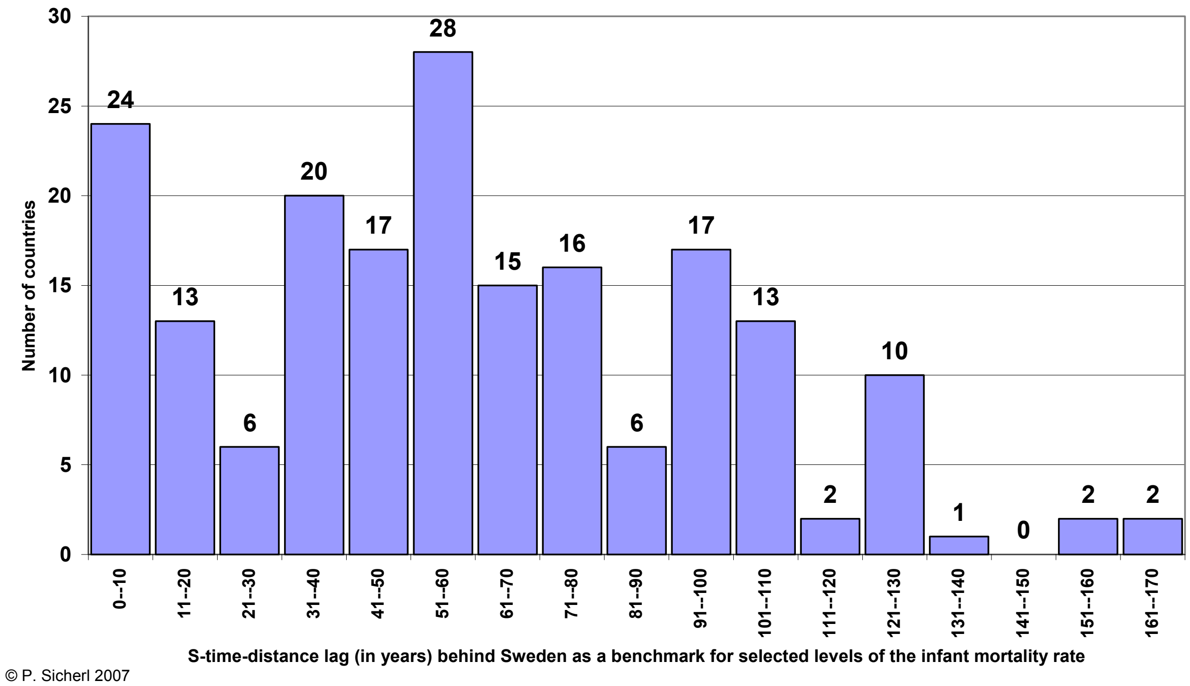

Figure 6. Frequency distribution of time lag of 192 countries behind Sweden for 2005 for infant mortality rate (for S-time-distance in years)

In addition to the more discussed S-time-distance measure the second new statistical measure S-time-step is used to compare the velocity of improvements in reducing infant mortality rate between two consecutive levels of the indicator. Namely, an interesting analytical and policy question is whether the developing countries are now improving the situation with respect to infant mortality faster than did the now developed countries (using Sweden as the representative case) at the same levels in the past.

Tables 1, 2 and 3 are meant to provide a visual guide to the procedure of gap timing without discussing the substantive issues beyond this methodological purpose. Table 1 is the empirical example of the respective theoretical **time matrix table** referred to earlier. Time when a given level of the indicator was achieved is estimated for a selected range of levels of the indicator (in this case infant mortality rate). The time matrix has the characteristics of a table-figure combination; it is possible to quickly observe visually the approximate range of the indicator within which the values for each unit were moving.

With Sweden as a benchmark, the corresponding values of **S-time-distance** for a given level of the indicator in Table 2 are obtained if we subtract vertically the estimated time for the respective country from that of Sweden. The estimate of **S-time-step** in Table 3 is obtained by subtracting horizontally for each unit separately the respecting times between two neighbouring levels of the indicators. It measures the time that was needed for the change between the two consecutive levels of the indicator. The shorter the time needed the higher the velocity of movement between the respective levels of the indicator.

TABLE 1
TIME MATRIX FOR CALCULATION OF S-TIME-DISTANCE AND S-TIME-STEP

Time when a given level of the infant mortality rate was attained by each unit

Level	5	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Sweden	1993	1973	1954	1944	1937	1930	1924	1918	1913	1908	1902	1890	1875	1865	1856	1846	1832	1812	1792
Industrialized countries	2005	1988	1971	1962															
World							1998	1986	1979	1974	1969	1965	1961						
Developing countries							2003	1992	1985	1979	1974	1970	1967	1963	1960				
Least developed countries											2002	1994	1987	1980	1975	1971	1966	1961	
Latin America and Caribbean				2000	1992	1986	1981	1976	1972	1968	1962								
East Asia and Pacific				2003	1994	1984	1978	1975	1971	1969	1967	1965	1963	1961					
Central and East. Europe, CIS				2004	1997	1984	1976	1968											
Middle East and North Africa						1999	1990	1987	1983	1980	1978	1975	1972	1969	1966	1963			
South Asia								2002	1995	1990	1986	1982	1977	1970	1964				
Eastern and Southern Africa											1997	1983	1977	1973	1968	1963			
Sub-Saharan Africa												1995	1980	1976	1972	1968	1963		
Western and Central Africa												2003	1989	1979	1975	1970	1966	1962	

Source: Own calculations based on UNICEF data for period 1960-2005, long term series for Sweden from B.R. Mitchell, International historical statistics, Europe 1750-2000, Fifth Edition, Palgrave, MacMillan, New York

TABLE 2

S-TIME-DISTANCE LAG (IN YEARS) BEHIND SWEDEN AS A BENCHMARK FOR SELECTED LEVELS OF INFANT MORTALITY RATE

(- ahead in time, + behind in time: -time lead, + time lag against Sweden)

Level	5	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrialized countries	12	14	18	17															
World							74	68	66	66	66	75	86						
Developing countries							79	73	72	71	72	80	91	98	105				
Least developed countries											100	104	112	115	120	125	134	149	
Latin America and Caribbean				56	55	56	57	58	59	60	59								
East Asia and Pacific				58	57	54	55	57	58	61	64	75	88	96					
Central and East. Europe, CIS				60	59	54	53	49											
Middle East and North Africa						69	66	68	70	73	75	85	97	104	110	117			
South Asia								83	81	82	83	92	102	105	109				
Eastern and Southern Africa											95	93	102	107	112	117			
Sub-Saharan Africa												105	105	111	116	122	131		
Western and Central Africa												113	114	114	119	124	134	150	

TABLE 3

S-TIME-STEP IN YEARS

Time elapsed between two consecutive levels of the infant mortality rate

Level	5	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Sweden	20	19	9	7	7	7	5	5	5	5	13	15	10	10	10	14	20	20	
Industrialized countries	18	16	9																
World							11	7	6	5	4	4							
Developing countries							11	7	6	5	5	3	3	3					
Least developed countries											8	8	7	5	5	5	5		
Latin America and Caribbean				8	6	6	4	4	5	6									
East Asia and Pacific				9	10	6	3	3	3	2	2	2	2						
Central and East. Europe, CIS				8	13	8	8												
Middle East and North Africa						9	3	3	3	3	3	3	3	3	3				
South Asia								7	5	4	4	5	7	6					
Eastern and Southern Africa											15	6	4	5	5				
Sub-Saharan Africa												15	4	4	4	5			
Western and Central Africa												14	10	4	4	4	4		

The corresponding results[4] for S-time-distance lag behind Sweden for the selected levels of the infant mortality rate in Table 2 are presented for regions and selected groupings. Without going into details one can observe that, with the exception of the least developed countries and Latin America and Caribbean, the previous clear trend of diminishing S-time-distances from Sweden at the higher levels of the infant mortality has in the last period started to show signs of stagnation or of reversal at lower levels of the indicator.

S-time-step in Table 3 as a possible velocity measure of improvements at given levels of the indicator could show further information for this debate. The predominantly U-shaped pattern for Sweden for a period of about two hundred years can lead to an interesting initial hypothesis. In the period before 1902, i.e. before reaching the level of the indicator of 100 Sweden needed a period between 10 and 20 years to achieve a decrease of infant mortality rate of 10 points. The question arises as to whether these results were influenced by low level of knowledge and technology, by specific situation in the country at that time, by the low level of development, or by a combination of such factors. Such analysis in different countries would be helpful also for setting future targets for development goals. Between the levels of the infant mortality rate from 100 to 30 Sweden needed only 6-7 years to decrease the infant mortality rate by 10 points.

The increase in S-time-step after that level is easy to explain. One should expect such development as the value of the indicator approaches slowly in an asymptotic way the best possible value. This example of the methodological procedure on a simple transparent indicator is an introduction to the later application to the trends in the composite Human Development Index (HDI).

Life expectancy

We follow the same procedure in using Sweden as benchmark for female life expectancy. The long-term series for Sweden from Mitchell (2003) is compared with the estimates for 2005 for 190 countries on the WHO web page. Figure 7 presents the frequency distribution of countries with respect to S-time-distance from the historical development for life expectancy in Sweden. The modus of the distribution is again in the group 51-60 years as in the case for infant mortality rate, the median value is 53 years. The median value of the S-time-distance distribution of countries for female life expectancy is 4 years less than for the infant mortality rate and 27 years less than for the GDP per capita.

Composite indicators and S-time-distance: the example of Human Development Index

An example of complementing static measures of disparity with time distances for a composite indicator is presented for Human Development Index. HDI is an established composite indicator combining life expectancy index, education index and GDP index (UNDP, 2007) and the time series of HDI for selected years are now available for the period 1975-2005 (UNDP, 2008).

It is a very wide range of HDI. In 1975 the range was from 0.245 for Mali to 0.883 for Switzerland, for 2005 the range was from 0.336 for Sierra Leone to 0.968 for Norway. Since the time series goes back only to 1975 it is not possible to calculate time distances from Sweden as a long-term benchmark as it was done for other indicators.

[4] For more details see Sicherl (2007c).

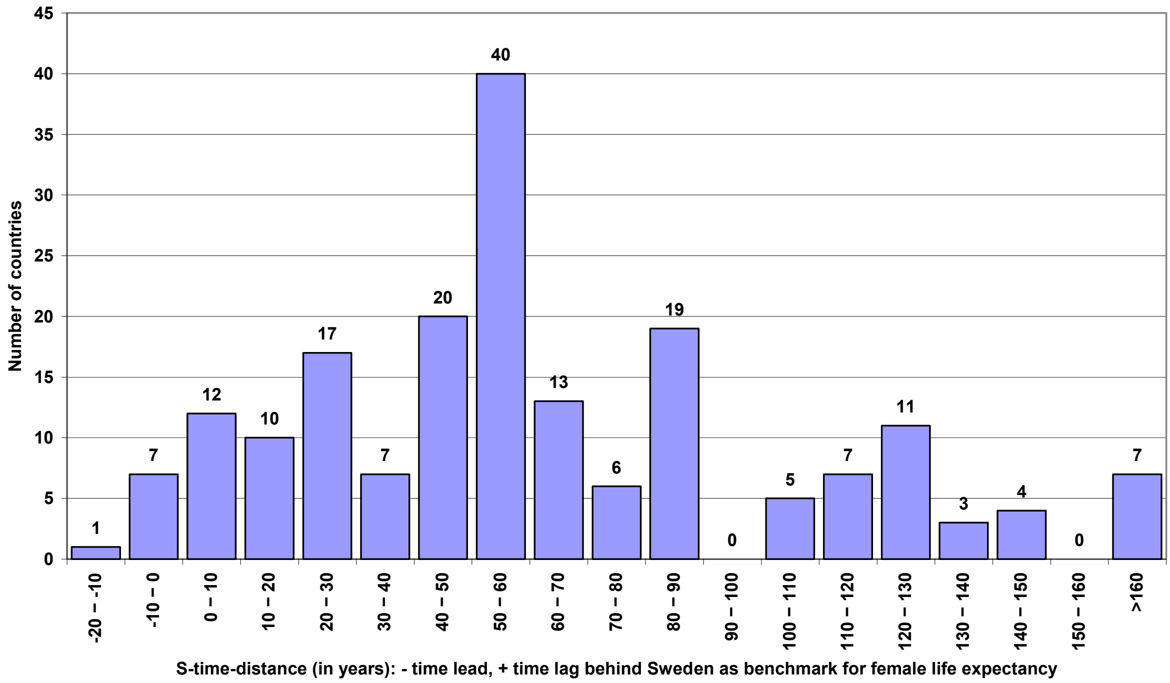

Figure 7. Frequency distribution of time lag for 190 countries for 2005 for female life expectancy compared to the long term trend for Sweden as benchmark

Therefore in this empirical example the time matrix for HDI in Table 4 will be limited to the results for the group of the EU countries with an addition of Korea and China. It should be mentioned that 'time series data are commonly flawed', as data collection may change and interpolations are used for years between censuses (UNDP 2007). It is also pointed out that one of the methods for normalization is distance to a reference (ibid., p. 119). S-time-distances in Figure 8 are distances for 2005 from the benchmark Greece for a given level of the HDI. This is a different specific normalization method from that mentioned in the UNDP primer but it shows that S-time-distance belongs to the generic normalization method: distance to a reference.

Notwithstanding these problems the selected empirical example will raise an important policy question. Static disparities in HDI appear small while S-time-distances are large. This possible divergence may be important also when considering other composite indicators.

Figure 9 shows percentage differences in HDI from benchmark Greece for 2005. Obviously using this relative static measure one gets the impression that differences within the EU are small. The level of Ireland is 4 percent higher than in Greece and that of Romania 12 percent lower than in Greece. The maximum range is thus only about 16 percent. This does not seem realistic. There are two simple ways out of this situation. Firstly, to make a statement that the HDI is good only for establishing rankings and that data cannot be compared over time at all. Such a position would be a pity in view of the large input of HDR activity on the world and national levels. Secondly, this work could be supplemented with S-time-distance analysis at various levels to show the second dimension of disparities.

TABLE 4

TIME MATRIX FOR HDI TREND: TIME WHEN A GIVEN INDICATOR LEVEL WAS ATTAINED

An example how analytical statistical tables can present time dimension in a new additional way for HDI

Level	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96
Norway																	1975	1978	1980	1985	1989	1991	1993	1996	1998	2001
Sweden																		1979	1984	1988	1991	1993	1994	1996	1999	
Netherlands																		1978	1982	1985	1989	1992	1994	1997	2003	
Ireland													1978	1982	1985	1987	1989	1991	1993	1995	1997	1998	2000	2002	2003	
Finland															1976	1979	1981	1984	1986	1989	1992	1995	1998	2000	2004	
France																1976	1979	1983	1986	1988	1991	1994	1997	2001	2004	
Belgium																1977	1980	1984	1987	1989	1991	1993	1995	1999		
Austria															1976	1979	1983	1986	1988	1990	1993	1996	1998	2001		
Denmark																		1978	1985	1991	1993	1996	1999	2002		
Spain															1976	1979	1983	1986	1988	1991	1994	1997	1999	2002		
UK																1980	1985	1988	1990	1991	1993	1994	1998	2003		
Luxembourg														1976	1980	1984	1986	1988	1990	1992	1994	1997	2000	2004		
Italy															1977	1980	1985	1987	1990	1992	1995	1998	2001	2005		
Germany																	1984	1987	1990	1992	1994	1997	2001			
Greece															1978	1982	1986	1993	1998	2001	2002	2004				
Slovenia																1995	1997	1998	2000	2002	2004					
Portugal										1978	1981	1983	1985	1987	1989	1991	1993	1994	1996	2003						
Cyprus											1980	1983	1985	1988	1990	1992	1995	1997	1999	2004						
Czech Rep															1993	1998	2001	2003	2005							
Malta				1975	1977	1978	1980	1981	1983	1985	1987	1988	1990	1991	1994	1996	1998									
Hungary									1976	1980	1984	1996	1997	1999	2001	2003	2004									
Poland											1991	1994	1996	1998	2000	2002	2005									
Lithuania										1996	1997	1999	2000	2001	2003	2005										
Estonia										1996	1997	1999	2000	2002	2003	2005										
Slovakia																2005										
Latvia								1996	1997	1998	1999	2000	2002	2003	2004											
Bulgaria								1982	1997	2000	2002	2004														
Romania								2000	2002	2003	2005															
China	1997	1999	2000	2001	2002	2003	2004																			
Korea		1976	1978	1979	1980	1982	1983	1984	1986	1987	1988	1989	1991	1992	1993	1995	1996	1998	2000	2001	2003	2005				

TABLE 5

S-TIME-STEP: HOW MANY YEARS WERE NEEDED TO REACH THE NEXT LEVEL OF HDI

Level	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96
Norway																	2.6	2.8	4.5	3.8	2.6	2.0	2.1	2.5	3.0
Sweden																		4.6	4.5	2.8	1.6	1.6	2.3	2.9	
Netherlands																		3.9	3.5	3.3	2.8	2.5	3.3	5.2	
Ireland													3.6	3.1	2.2	2.1	2.1	2.2	2.0	1.5	1.5	1.5	1.8	1.8	
Finland															2.5	2.6	2.8	2.5	2.3	3.0	3.8	2.3	2.3	4.2	
France																3.1	3.9	3.0	2.2	2.3	2.8	3.3	3.8	3.6	
Belgium																3.0	3.6	2.8	2.5	2.0	1.8	1.8	3.9		
Austria															3.6	3.6	3.0	2.2	2.2	2.6	2.6	2.5	3.0		
Denmark																		6.9	5.6	2.8	2.7	2.6	3.1		
Spain															2.9	3.4	3.3	2.6	2.7	2.8	2.8	2.8	2.9		
UK																5.0	2.5	2.5	1.3	1.3	1.3	3.7	5.5		
Luxembourg														3.6	3.8	2.5	1.9	1.8	2.2	2.2	2.8	3.1	3.3		
Italy															3.1	5.5	2.2	2.2	2.7	2.8	3.1	3.2	3.3		
Germany																	3.0	2.6	2.2	2.2	3.0	4.1			
Greece															3.5	4.1	7.4	4.7	2.8	1.7	1.7				
Slovenia																1.5	1.5	1.5	1.9	1.9					
Portugal										3.2	2.3	2.2	1.9	1.9	1.8	1.7	1.7	2.1	6.5						
Cyprus											2.6	2.5	2.2	2.2	2.6	2.6	2.2	2.2	4.2						
Czech Rep															4.7	3.3	2.0	2.0							
Malta				1.5	1.5	1.5	1.8	1.8	1.8	1.5	1.5	1.5	1.9	2.1	2.2	2.5									
Hungary									3.3	4.1	11.8	1.8	1.8	1.8	1.7	1.7									
Poland											3.1	1.9	1.7	1.7	2.5	2.8									
Lithuania										1.3	1.3	1.3	1.6	1.6	1.6										
Estonia										1.4	1.3	1.4	1.6	1.6	1.6										
Slovakia																									
Latvia								1.1	1.1	1.1	1.2	1.3	1.3	1.3											
Bulgaria								14.5	3.3	2.1	2.1														
Romania								1.5	1.5	1.5															
China	1.2	1.2	1.1	1.1	1.1	1.1																			
Korea		1.5	1.5	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.6	1.6	1.6	1.7	1.7	1.7				

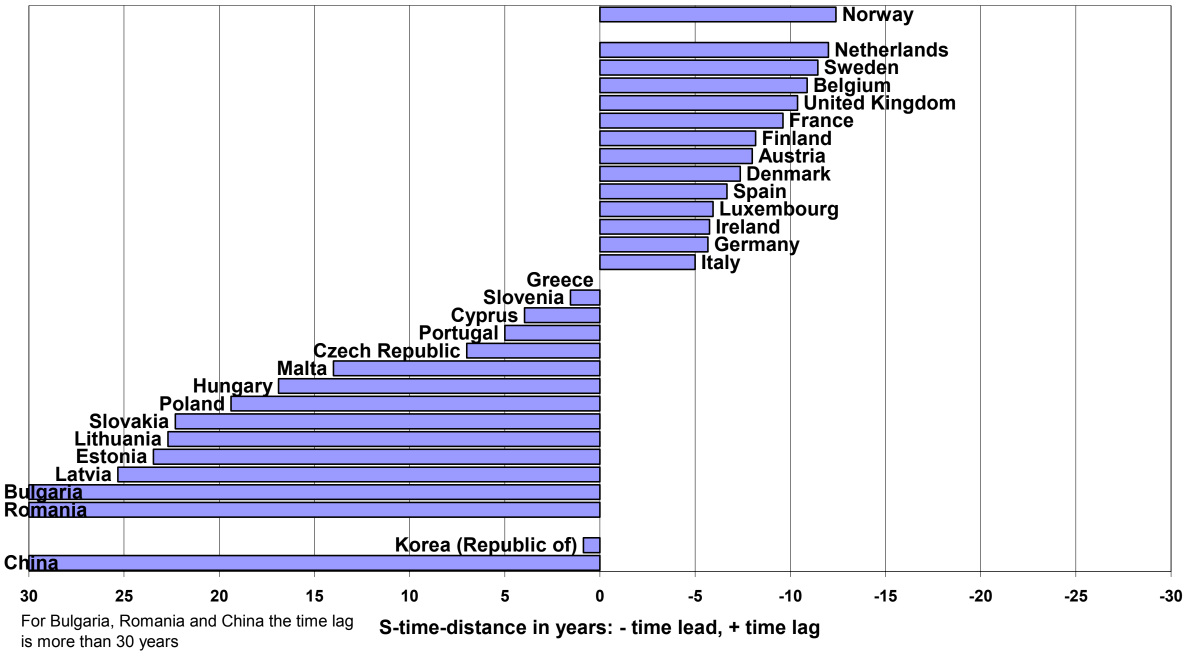

Figure 8. S-time-distance in years from Greece for HDI for 2005

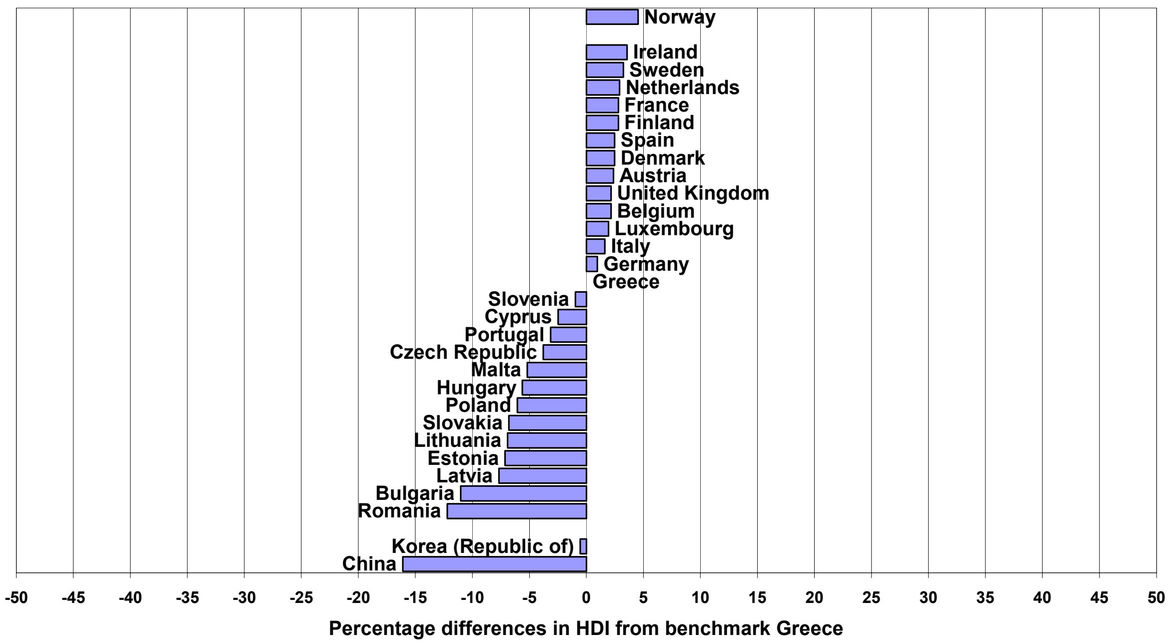

Figure 9. Percentage differences in HDI from benchmark Greece for 2005

S-time-distances in Figure 8 show a very different picture. Sweden was 11 years ahead of Greece and Romania, Bulgaria are more than 30 years behind Greece. This gives a very different perception of the distance and a rough impression of the difficulty of reducing the disparity in HDI. Percentage difference of 16 percent and time distance of about 40 years are of very different order of magnitude and should be examined simultaneously.

S-time-step presented in Table 5 show how many years were needed to reach the next level of HDI. This is an alternative way to look at the dynamics of changes. This measure also gives an impression of the difficulty of increasing the value of the HDI in the past, the outlook will of course depend on future performance. The table-graph presentation capability of Table 5 together with Figures 8 and 9 show e.g. that Korea has in the period 1976 to 2005 increased over 20 levels of HDI. China started from lower level and entered the range of HDI level higher than 0.7 only in 1997. However, they are improving their position even faster than it was the case of Korea; they needed only slightly more than one year to gain the next 0.1 higher value of the HDI.

This brief example raises a set of questions rather than presenting answers:

1. How to treat and interpret intertemporal changes in composite indicators?
2. How to make assumptions used in arriving at the static picture of values of composite index consistent with the certain intertemporal measures and interpretations?
3. To what extent is S-time-distance useful in this general context? Under what conditions can it be combined with other measure and concepts of distance?

In the dynamic world it is hardly satisfactory to rely only on static measures of disparity which are insensitive to the magnitudes of the growth rates and take into account only differences in the growth rates between the units. The value judgment that people attach to the time dimension of disparities and to the static dimension of disparity is an open question for interdisciplinary research. However, it may be safe to assume that a situation with 50 per cent static difference and time distance of 10 years is preferable to the situation with the same static difference and time distance of 40 years discussed in Sicherl (2007a). The conventional analysis based on only ratios, percentage differences, Gini coefficients or Theil indexes alone does not distinguish such situations as different degrees of disparity. If one does not use explicitly the broader framework outlined here, there is a possibility that in political debate and policy formulation various interest groups would intentionally look only at the measure which will suit their particular interest.

4. Conclusions

The first conclusion deals with methodological aspects of measuring progress and wellbeing. The perception of well-being is subjective. An individual assigns different weights to various elements of wellbeing and also gives different weights to the possible measures by which such elements are measured and presented. The concept of wellbeing has to deal not only with the categories, measurement, and data availability but also with measures for interpersonal and inter-temporal comparisons of the chosen constituent elements.

It was stated that the purpose of the OECD World Forum is to convene and promote research and information sharing among countries, allowing them to compare strategies intended to measure and assess the overall “position” and “progress” of a certain political entity (country, region, etc.) vis-à-vis other similar entities (Giovannini, 2005). Within such an undertaking in the attempts to develop innovative measures of wellbeing, including both composite indexes and sets of indicators, one has to look also for innovative measures that present data through novel additional perspectives in an understandable way to the actors of decision-making.

S-time-distance measure is such a measure with clear interpretability that delivers a broader concept to look at data and facilitates the comparison of situations. This innovation opens the possibility for simultaneous two-dimensional comparisons of time series data: vertically (standard measures of static difference) as well as horizontally (Sicherl time distance). No earlier results are lost or replaced but additional information and perspective hidden in the existing data is now made available due to an added dimension of measurement and analysis.

We need innovative perspectives also in statistical concepts and measures, not only in qualitative and other dimensions. The possibilities for S-time-distance analysis range from a simple analysis of monitoring implementation of targets[5] to more complex benchmarking and to a very complex econometric analysis[6]. The time distance approach can thus contribute a useful piece of the mosaic in building up an internationally supported methodology to measure and assess the overall "position" and "progress" among and within countries. The aim of the article is to explain how it is possible to incorporate such a broader way of thinking and its changed semantics into the present state-of-the-art of comparative analysis.

Time, besides money, is one of the most important reference frameworks in a modern society. The main proposition is that people compare over many dimensions and over time. The novel time distance methodology offers improvements in the present state-of-the-art at both conceptual and application levels (Sicherl, 2007d):

- The new generic time distance approach offers a new view of data that is exceptionally easy to understand and communicate, and it allows for developing and exploring new hypotheses and perspectives.
- It can also make important contribution to exploiting information resources in new ways and to visualisation of findings, and it is well placed to be used jointly with other methods.
- Expressed in time units it is an excellent presentation tool easily understood by policy makers, managers, media and general public and can support decision-making and influence public opinion.
- The new view of information, using levels of the variable(s) as identifiers and time as the focus of comparison and numeraire, is theoretically universal, intuitively understandable and can be usefully applied as an important analytical and presentation tool at various levels to a wide variety of substantive fields.
- At the empirical level the perception of the degree of disparity may be very different in static terms and in time distance.
- The broader dynamic analytical framework also encourages cross-examinations of conclusions based on static and time distance measures to test their separate as well as joint relevance for development and policy debate and for cross-checking other statistics and indicators.

People are assessing the degree of disparity also in the long-term perspective, and not only at a given point in time. This is first and foremost a question of the perception of disparities and

[5] Examples of application to monitoring the Lisbon strategy indicators and sustainable development indicators for the EU are e.g. Sicherl (2007d) and for MDG at the world and national levels e.g. Sicherl (2007b, 2007e, 2008b).
[6] Granger and Jeon (1997, 2003) used time distance as a criterion for evaluating forecasting models.

of the possible welfare and political consequences, which arise from using an analytical framework that is closer to the dynamic reality and the way in which people perceive disparities[7]. This framework also offers improved semantics for analysis and policy debate. The comparability of data over a longer time span to support a broader set of measures for more relevant analytical conclusions and policy debate will have to be given a higher priority in the work of the statisticians.

Secondly, in the empirical part of this paper S-time-distances were estimated for 160 countries for GDP per capita in 2003 and for around 190 countries for infant mortality and female life expectancy in 2005 against the long-term series for Sweden as a benchmark. The results are calculated for all countries but the lack of space prevents their presentation here. Only for the latest years used here for the three indicators together there are 542 S-time-distances that could be later analysed further in relation to the static measures of disparity, with respect to world regions or other characteristics. Depending on the availability of time series for these three and other indicators they can be compared against the benchmark Sweden over many years resulting in time series of S-time-distances for many countries. The outcome could be thousands of estimates that can be further analysed and processed. The paper presented only some overall results, mostly in terms of the frequency distribution of countries with respect of S-time-distance deviations in time from Sweden.

It showed an added dimension of the disparity in the world: one half of the countries (80 countries) were lagging Sweden by more than 70 years, of them 36 countries even for more than 160 years. For infant mortality the median value was 57 years and for female life expectancy 53 years. The respective Gini coefficient for GDP per capita of 0.515 is the static counterpart of the S-time-distance measure. Both measures are complementing each other but the story-telling capability to policy makers and public concerned with the world situation is much greater for the S-time-distance results.

Comparisons between EU27, USA and China for GDP per capita, female life expectancy and internet users per capita illustrates the theoretical points that the degree of disparity may be very different in static terms and in time distance. The ratio USA/China as a representative of static relative disparity was 4.9 for GDP per capita in 2007, for female life expectancy only 1.08, and for internet users per capita according to ITU data 6.7 for 2006. Static degree of disparity would seem to be the highest for internet users per capita, following for GDP per capita and hardly noticeable for female life expectancy. This would be a one-sided conclusion if time distance perspective would not be taken into account. Namely, ceteris paribus, time distance is a decreasing function of the magnitude of the growth rate of the indicator. It has been shown that comparing across indicators S-time-distance in many cases produces different and sometimes very surprising new qualitative conclusions.

For GDP per capita China lags 48 years behind the EU and about 70 years behind the US; for female life expectancy about 38 years behind the EU and about 33 years behind USA; for internet users per capita China was in 2006 according to ITU data 6 years behind the EU and 10 years behind the US. The time distance perspective adds a completely different perception

[7] One can also mention in passing another example that is related to disparities within countries. For instance, the very high rate of growth of the Chinese economy is decreasing the time distances between various segments of the society and thus may be an important reason why disparities have not been a major problem yet. A significantly lower rate of growth may seriously affect also the perception of the degree of disparity not only within China but also within many countries, with considerable economic and political consequences.

of the degree of disparity across these indicators. For a better perception of the reality all of the perspectives have to be studied simultaneously. The present state-of-the-art overlooks this additional information available in time series databases resulting in unnecessary loss of information and inefficient utilization of data.

Another example of the dynamic features shows that notwithstanding the current significant gap in GDP per capita with EU and US, China's pace of growth is cutting this time distance dramatically. Two alternatives are evaluated: time needed to reach the present values of the EU and USA and full convergence. This paper is based on data from Angus Maddison and IMF. However, in the section on 'what if' scenarios we undertake a sensitivity analysis exercise and a double calculation is run for both EU-China and US-China comparisons, also on the basis of the study of the International Comparison Program (ICP) published by the World Bank. The latter show values of GDP for 2005 that were for China and India about 50 percent lower than the former. This huge difference which would greatly increase the income disparities in the world if correct. It is important that the statistical community settles this wide discrepancy as soon as possible.

The S-time-distance analysis is for infant mortality rate and for HDI complemented by the analysis of another statistical measure S-time-step. The concept of S-time-step measures the growth characteristics of a series, i.e. how many years were needed to reach the next level of HDI. This is an alternative way to look at the dynamics of changes. This measure gives an impression of the difficulty of increasing the value of the variable in the past. Such analysis in different countries would be helpful also for setting future targets for development goals.

Analysis of the Human Development Index (HDI) as an example of a composite indicator of wellbeing showed even more drastic difference between the conclusion reached by static measures and S-time-distance. Static disparities in HDI appear small while S-time-distances are large. This possible divergence may be important also when considering other composite indicators. Within the EU the maximum range of HDI in 2005 was 16 percent, while for S-time-distance the maximum range was in the order of 40 years. This example raises a set of questions rather than presenting answers: how to treat and interpret inter-temporal changes of composite indicators?

These methodological examples can help us to broaden the analytical and policy perspective, asking new questions and learning from the other's experience. In a similar way detailed examination of the situation for specific grouping, for individual countries, regions, gender or socio-economic groups could be undertaken for a number of indicators in a variety of fields of concern.

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Annex

TABLE A1
DIVERSE DATA ON GDP BY IMF AND INTERNATIONAL COMPARISON PROGRAMME PUBLISHED BY WB

List by the International Monetary Fund		**List by the ICP (World Bank)**	
Country	**GDP (PPP) $m**	**Country**	**GDP (PPP) $m**
World	72337649	World	54980400
European Union	14953057	European Union	13018500
United States	13543330	United States	12376100
China	11606336	China	5333200
India	4726537	Japan	3870300
Japan	4346080	Germany	2514800
Germany	2714469	India	2341000
United Kingdom	2270884	United Kingdom	1901700
France	2040109	France	1862200
Brazil	2013893	Russia	1697500
Russia	1908739	Italy	1626300
Italy	1888492	Brazil	1585100

Source: Wikipedia, accessed January 31, 2008