The Millennium Project

2011 STATE OF THE FUTURE

JEROME C. GLENN, THEODORE J. GORDON
AND ELIZABETH FLORESCU

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Jerome C. Glenn, Theodore J. Gordon,
and Elizabeth Florescu

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+1-202-686-5179 (F/P)
info@millennium-project.org

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Appendix B: State of the Future Index

Appendix B I. Global SOFIs

Appendix B: State of the Future Index

APPENDIX B VI.TIME DISTANCE METHOD

by
Pavle Sicherl
The Millennium Project South East Europe Node

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Executive Summary

Time distance is a novel method of displaying time series data that provides new insights into existing data. It provides two additional generic statistical measures, and is a presentation tool for policy and business analysis. Expressed nation to nation comparisons in time units it is readily understood by policy makers, managers, media and general public.

The brief description of the method presented here includes history of the method, its main characteristics, procedure, strength and weaknesses as well as frontiers. The time distance method has usually been used with macro indicators, dealing with disparities between countries and regions, economic, social and ICT indicators, benchmarking and monitoring implementation of targets. In looking at its frontiers we intend to test and apply it to SOFI data. It works best with monotonic time series. The extension to measuring deviations between actual and estimated values in regressions and models is a long-term possible aim.

The strength of the S-time-distance concept lies in the fact that it enables additional exploitation of data and an alternate means of visualization of time related databases and indicator systems. Level-time matrix provides (with some interpolation) a visual impression of both levels of the indicator and the number of steps the indicator has experienced over time. Each selected level of an indicator is related also to the time when it was achieved. Two generic statistical measures, S-time-distance and S-time-step, can be calculated from such a table.

Time distance and time step bring new semantics to policy debates and management decisions.When countries are comared, time distance is a presentation of when various countries reach a given level of performance; time step presents the time required for each country to reach the next level of achievement. These measures can be used to compare expectations with reality,as actual arrival times of a train can be compared with its timetable.. Using these expressions in social, business and technical contexts S-time-distance and S-time-step can be facilitate presentations and enhance communications for different levels of decision makers.

Three examples are included here to show how analysis and visualization of indicators over many years and many units can be performed. The first looks at disparities in composite indicator Human Development Index (HDI) between world regions, comparing levels of human development with those achieved in China. The disparities in the HDI in the world are very large; the time matrix visualization shows that at a glance and allows also estimating the time distance dimension of disparities. S-time-step is a complementary measure of the dynamics of the indicator for a given unit that is very easy to understand. For the medium human development group on the average 1.3 years were needed to come to the next level of the HDI.

The second example analyses life expectancy among countries in the group that enjoy very high human development and in comparison with Korea. The best performer over the three decades was Korea with the average value of S-time-step of 2 years, i.e. 2 years were needed to increase life expectancy by one year. Such analysis could be performed also for other indicators.

The third time matrix is for elderly population and covers a period of 100 years, 40 years of which are OECD projections in the Factbook 2010. It is difficult to imagine that the usual table of 34 OECD countries across 100 years with 3400 entries would allow such a compressed essence of the long-term information and visualization for relevant perception of the situation.

Time Distance Methodology

I. History of the Method

Development of time distance methodology started as an outcome of policy research of regional disparities in Yugoslavia at the end of 1960s for budget subsidies for the Federal Assembly. In the period 1952-1966 all republics and autonomous provinces were growing very fast at about the same rate of growth so that relative indices were approximately constant. In this study, regional disparities were expressed as difference in units of time (years) (Sicherl, 1969). In publication abroad (Sicherl 1973) time distance as a dynamic measure of disparities in social and economic development was extended from regional analysis to disparities between countries and over a broader range of indicators.

From the methodological point of view the important step was extension of time distance concept to measuring deviations between actual and estimated values in regressions and models (Sicherl 1994, 1997) and to monitoring implementation of policy or business targets (ibid.). This opens a wide range of possible applications for which additional software needs to be developed. Recently the presentation of time matrix as level-time matrix enabled a simple visualization of indicators over many years and many units.

The time distance method has been used frequently mostly with macro indicators to mention a few (although it could by analogy be also useful for micro analysis). For benchmarking it was used by EUROCHAMBRES Brussels: ‘A Comparison of European and US Economies Based on Time Distances’. International Telecommunication Union study ‘Measuring the Information Society 2010’ treated S-time-distance as an alternative way of looking at the digital divide in the world. On the global level it showed that the speed of diffusion of ICT sector indicates its much greater potential for catching up and becoming an important instrument to reduce world disparities. Time distance method was presented at the EUROSTAT, Luxembourg. The role of indicators for measurement for success was presented at the Centre for eGovernance Development and Microsoft conference ‘ICT solutions for innovative economic and social development’, which was followed by ‘Digital Divide in the Dynamic Time Distance Analytical Framework’. It was used in the project ‘Slovenia – Low Carbon Society’. One example from the visual overview of 50 years in OECD countries with time distance methodology will be presented here. It has also been applied to Millennium Development Goals and Lisbon Strategy targets.

II. Description of the Method

Here we shall only briefly define the two novel generic statistical measures, S-time-distance and S-time-step, to indicate the overall framework (Sicherl 2006, 2007).

Time distance in general means the difference in time when two events occurred and as such is used in many fields, like history or spatial analysis. However, S-time-distance is a special category of time distance, which is defined for the level of the analyzed indicator. 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. The observed distance in time (the number of years, quarters, months, etc.) 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.

Namely, when we compare time series for a given variable for two or more units there are two obvious directions of comparison: by time and by level of the variable. We need both. This innovation opens the possibility for simultaneous two-dimensional comparisons of time series data in two specified dimensions: vertically (standard measures of static difference) as well as horizontally (Sicherl time distance), providing a new dimension of analysis to a variety of problems. Granger finds the time distance concept a useful addition to the present state-of-the-art (Granger, Jeon 1997)[1].

The usual time series table is transformed into the level-time matrix from which the two time distance generic measures can be derived (Sicherl 2006, 2007).

Table 1. *Time matrix: time when a specified level of the variable was achieved in each compared unit*

Level	**Time $t_i(X_L)$**	**Time $t_j(X_L)$**
X_{L1}		$t_j(X_{L1})$
X_{L2}	$t_i(X_{L2})$	$t_j(X_{L2})$
X_{L3}	$t_i(X_{L3})$	$t_j(X_{L3})$
…	…	…
X_{Ln}	$t_i(X_{Ln})$	

S-time-distance measures the distance (proximity) in time between the points in time when the two compared series reach a specified level of the variable X. It compares two series by subtracting the respective times between the two units for a given level in the time matrix.

S-time-distance for a given level of X_L is defined as[2]

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

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)

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

The second measure **S-time-step** is derived by subtracting the respective times in the series for each unit in the time matrix for consecutive levels of the variable. It measures the growth characteristics of a series, using the inverse relation to the conventional $\Delta X/\Delta t$ or growth rate metrics (Sicherl 2006, 2007).

III. How to Do It

Starting with selected levels of indicator, we are looking for the times when these levels were attained in the units being compared. The easiest calculation procedure for S-time-distance and S-time-step starts with the calculation of the level-time matrix (shown in the examples below), i.e. specifying series of selected levels of the variable and looking up the corresponding times.

Two operators applied to such level-time matrix lead to the derivation of two statistical measures, expressed in standardized units of time: S-time-distance and S-time-step. S-time-distances for selected levels of X_L are arrived at by subtracting the respective times between units in the level-time matrix. Subtracting the respective times in the series for each unit in the time matrix for consecutive levels of the variable we get S-time-step, a possible measure of the dynamic characteristics of a series.

IV. Strength and Weaknesses of the Method

The strength of the S-time-distance concept lies in the fact that it enables additional exploitation of data and visualization for time related databases and indicator systems. The present state-of-the-art neglects this additional information available in time series databases and thus leads to an information loss that has no justification. The results and conclusions based on the two-dimensional analysis, static measures and time distance, can provide a new dimension and new insights, while none of the earlier results are lost or replaced. Another technical and presentation advantage is that time and time distance is comparable across variables, fields of concern, and units of comparison. This makes it an excellent analytical presentation and communication tool.

Since S-time-distance and S-time-step are expressed in time units, they are intuitively understood by policymakers, professionals, managers, media and the general public and help them in better understanding of the situation to form their subjective perception. Time distance and time step bring new semantics to policy debate and management decisions. Using these expressions in social, business and technical contexts S-time-distance and S-time-step can be very useful a presentation and communication tool useful to different levels of decision makers and interest groups in describing the situations, challenges and scenarios, for proactive discussion and presentation of policy and business alternatives to decision makers, media, the general public and mobilizing those participating in or being affected by the programs.

One of the possible weaknesses of the method is that calculating the times by interpolations may pose a problem in achieving accuracy of the level of the original data but it provids additional understanding about time dimension of disparities and is the basis for a good summary overview. Also, for the specified levels we may not get any intersection, or we get more intersections in case of series with changing directions, so one has to decide which one to take into account (first intersection, last, etc.). In the empirical examples here we take the last intersection. The year in the time matrix marked in bold shows the latest available year of data for selected countries. This can help to quickly observe whether there was a significant change in the observed period.

V. Frontiers of the Method

S-time-distance and S-time-step have, in addition to their use as descriptive statistical measures, the potential to provide new insights from existing data for a variety of situations in economics, management, research and statistics, asking new questions, formulating new hypotheses, establishing new semantics and reaching new conclusions.

There are many possible applications. As one of the interesting applications we intend to test and apply it to SOFI data, possibly in three directions.

1). Describing and comparing systemic SOFI over many units and many years
2). Describing and comparing various scenarios also with time distance measures
3). Time distance monitoring differences between actual and expected developments

At present we are dealing mostly with the points related to improved broader perception of the situation: description, multidimensional comparison and evaluation, presentation, visualization and semantics for policy and management. One can expect also more applications in the business and monitoring.

For the future one could foresee some further possible applications like stochastic models with S-time-distance (e.g. criterion for evaluating forecasting models (Granger and Jeon, 2003)) and extension of decision making models with S-time-distance. It may be possible hopefully to motivate researchers in other fields beyond social sciences to test, apply, and further develop time distance methodology and to develop software which can facilitate its use.

Empirical Examples

Example 1. Human Development Index (HDI) between world regions, levels of human development and China

The choice of using HDI for empirical example to demonstrate the application of the time distance method was based on several points. As we would like later to test and apply it to the analysis of SOFI and HDI is also a composite indicator with well documented database covering three decades of trends 1980-2010.

We prepared tables of time matrices and S-time-step values for 169 countries over that period. Since presentation of individual country results for over 30 years and 169 countries would imply a number of very large tables our example is limited to 4 human development groups and 6 world regions defined by the UNDP classification.

Table 2 shows the time matrix of the HDI values. The observed level-time table-graph in yellow colour shows the range of values achieved by a given group over the period, from available data.

This allows for a quick level comparison:
- of the situation in the world across the selected groups and three decades of development
- of how many steps over levels of the HDI was achieved for a given group, which is an additional visual indication of the dynamics that is later calculated in the S-time-step table.

One can immediately observe several features. Within the three decades covered by data there was no intersection (same level of the HDI) for the very high human development group with other groups. This means that the very high group is at least 30 years ahead of the high human development group. High human development group was at the level of 0.59 26 years ahead of the medium human development group (1984 and 2010). The last intersection of the medium and low human development groups was at the level 0.39, with the S-time-distance of 25 years at that level (1984 and 2009). Similar observations can be made for regions. Obviously, the disparities in the HDI in the world are very large; the time matrix visualization shows that fact at a glance and allows also estimating the time distance dimension of disparities.

The time matrix also shows that the greatest number of steps were achieved in the medium human development group and in the East Asia and the Pacific group. Table 3 presents the values of S-time-step, i.e. the number of years needed to reach the next level of the HDI for the analysed groups; this is a complementary measure of the dynamics of the indicator for a given group. For the medium human development group on the average 1.3 years was needed to come to the next level of the HDI, while for the very high human development group this average was 2.3 years as it is understandable that at very high levels of the indicator it is more difficult to progress. S-time-step is very easy to understand, probably easier than the percentage rate of increase. For instance, the time needed to increase to the level of the HDI of 1.3 years for medium group is an easily understood alternative to the more common use of average growth rate, in this case, 1.7 percent.

A very important theoretical and practical question is: How to treat and interpret intertemporal changes in composite indicators? E.g., different measures provide very different perceptions of the order of magnitude of disparities, static disparities in HDI appeared small and time distances in HDI were large; both need to be taken into account. The initial examples provided are important food for thought in this respect.

Table 2. *Time matrix: time when a given indicator level was attained*
A quick visual overview over all groups and regions (trends 1980-2010)

	Groups				Regions						
HDI Level	**Very high human development**	**High human development**	**Medium human development**	**Low human development**	**Latin America and the Caribbean**	**Europe and Central Asia**	**East Asia and the Pacific**	**Arab States**	**South Asia**	**Sub-Saharan Africa**	**World**
0.87	**2007**										
0.86	2003										
0.85	2000										
0.84	1998										
0.83	1996										
0.82	1994										
0.81	1992										
0.80	1991										
0.79	1988										
0.78	1986										
0.77	1984										
0.76	1982										
0.75											
0.74											
0.73											
0.72											
0.71		**2009**									
0.70		2007			**2009**	**2010**					
0.69		2005			2007	2007					
0.68		2003			2005	2005					
0.67		2002			2002	2004					
0.66		2000			2000	2002					
0.65		1998			1998	2000					
0.64		1996			1995	1998	**2010**				
0.63		1990			1993	1996	2008				
0.62		1988			1991	1987	2007				**2009**
0.61		1987			1989	1987	2006				2007
0.60		1986			1987	1986	2005				2005
0.59		1984	**2010**		1984	1986	2004				2004
0.58		1983	2008		1982	1985	2003	**2008**			2002
0.57		1982	2007			1984	2001	2007			2000
0.56		1981	2006			1984	2000	2005			1997
0.55			2004			1983	1999	2003			1994
0.54			2003			1982	1998	2002			1993
0.53			2002			1982	1996	2001			1991
0.52			2001			1981	1995	1999			1989
0.51			2000			1980	1994	1996	**2009**		1988
0.50			1998				1993	1994	2008		1986
0.49			1997				1992	1993	2006		1985
0.48			1995				1991	1991	2005		1984
0.47			1994				1990	1990	2004		1982
0.46			1993				1989	1989	2002		1981
0.45			1991				1988	1987	2001		
0.44			1990				1987	1986	2000		
0.43			1989				1986	1985	1998		
0.42			1987				1984	1983	1996		
0.41			1986				1983	1982	1994		
0.40			1985				1982	1981	1992		
0.39			1984	**2009**			1981		1991		
0.38			1982	2008					1989	**2008**	
0.37			1981	2006					1988	2006	
0.36				2004					1986	2004	
0.35				2003					1985	2003	
0.34				2001					1983	2002	
0.33				1999					1982	2001	
0.32				1994					1981	2000	
0.31				1990						1983	
0.30				1987						1981	
0.29				1985							
0.28				1982							

Source: Own calculations based on data from Human Development Report 2010, UNDP, Statistical Annex, Table 2, p. 151

Table 3. *S-time-step: how many years were needed to reach the next level of HDI*
A quick visual overview of dynamics over all groups and regions (trends 1980-2010)

	Groups				Regions						
HDI Level	Very high human development	High human development	Medium human development	Low human development	Latin America and the Caribbean	Europe and Central Asia	East Asia and the Pacific	Arab States	South Asia	Sub-Saharan Africa	World
0.87	3.7										
0.86	3.0										
0.85	2.1										
0.84	2.1										
0.83	1.8										
0.82	1.7										
0.81	1.7										
0.80	2.1										
0.79	2.3										
0.78	2.3										
0.77	2.3										
0.76											
0.75											
0.74											
0.73											
0.72											
0.71		2.0									
0.70		1.9			2.2	2.2					
0.69		1.5			2.2	2.1					
0.68		1.5			2.4	1.7					
0.67		1.5			2.4	1.6					
0.66		2.0			2.5	1.6					
0.65		2.0			2.5	2.3					
0.64		6.6			1.9	2.5	1.2				
0.63		1.3			1.9	8.0	1.1				
0.62		1.3			2.1	0.6	1.1				1.9
0.61		1.3			2.4	0.6	1.1				1.9
0.60		1.3			2.4	0.6	1.2				1.8
0.59		1.3	1.4		2.4	0.6	1.2				1.8
0.58		1.3	1.3			0.6	1.2	1.9			1.8
0.57		1.3	1.3			0.6	1.2	1.8			3.1
0.56			1.2			0.6	1.2	1.3			2.6
0.55			1.1			0.6	1.3	1.4			1.8
0.54			1.1			0.6	1.3	1.3			1.8
0.53			1.1			0.6	1.3	1.9			1.6
0.52			1.1			0.6	1.0	2.5			1.4
0.51			1.7				0.9	2.0	1.4		1.4
0.50			1.7				1.0	1.4	1.4		1.4
0.49			1.7				0.9	1.4	1.4		1.4
0.48			1.3				0.9	1.4	1.2		1.4
0.47			1.3				1.1	1.3	1.2		1.4
0.46			1.3				1.2	1.4	1.2		
0.45			1.3				1.2	1.3	1.2		
0.44			1.3				1.2	1.4	2.0		
0.43			1.3				1.2	1.3	2.0		
0.42			1.3				1.2	1.3	1.9		
0.41			1.3				1.2	1.4	1.8		
0.40			1.3				1.2		1.8		
0.39			1.3	1.9					1.5		
0.38			1.3	1.8					1.4	2.2	
0.37				1.6					1.4	1.5	
0.36				1.5					1.4	1.0	
0.35				1.5					1.4	1.0	
0.34				2.4					1.4	1.0	
0.33				5.2					1.4	1.0	
0.32				3.6						17.7	
0.31				2.6						1.6	
0.30				2.6							
0.29				2.6							
0.28											

Source: Own calculations based on data from Human Development Report 2010, UNDP, Statistical Annex, Table 2, p. 151

Table 4 is an excerpt from an analysis of over 160 countries. In each of the 4 groups we selected some first and last countries to make a provisional assessment of the situation over all countries. China was one the best performers so we have selected China to be one of the possible benchmarks to which we will compare other countries. Over the range of HDI 0.37-0.66 it was shown that China had no intersection with the best in the very high human development group like Norway or Australia and with the lowest countries in the low group like Niger and Congo. S-time-distance lead or lag from benchmark China in the table shows that e.g. the time lag for Bangladesh was 19 years, for Pakistan 17 years, for India 14 years. China was close to the lowest countries in the high human development group, e.g. Turkey which was 4 years ahead and less close to the lowest countries in the very high human development group like Portugal and Bahrain with China lagging for about 25 years.

Table 4. *S-time-distance in years*
(-) time lead, (+) time lag from benchmark China for a given level of HDI

	Very high human development				High human development			Medium human development			Low human development					
Rank	1	2	39	40	45	83	84	89	119	125	128	130	129	168	167	Rank
HDI Level	Norway	Australia	Bahrain	Portugal	Chile	Turkey	Algeria	China	India	Pakistan	Kenya	Ghana	Bangladesh	Congo (D. R.)	Niger	HDI Level
0.66			-25	-24	-21	-4	-3	0								0.66
0.65			-25	-25	-21	-5	-4	0								0.65
0.64			-25	-25	-21	-6	-4	0								0.64
0.63			-25	-26	-21	-6	-4	0								0.63
0.62			-25		-22	-6	-4	0								0.62
0.61					-24	-6	-4	0								0.61
0.60						-6	-4	0								0.60
0.59						-7	-4	0								0.59
0.58						-7	-4	0								0.58
0.57						-7	-5	0								0.57
0.56						-8	-5	0								0.56
0.55						-9	-6	0								0.55
0.54						-9	-7	0								0.54
0.53						-9	-7	0								0.53
0.52						-10	-8	0								0.52
0.51						-10	-8	0	14							0.51
0.50						-10	-9	0	14							0.50
0.49						-10	-9	0	13	17						0.49
0.48						-10	-9	0	13	16						0.48
0.47						-11	-9	0	13	15	19					0.47
0.46							-9	0	12	14	18	19	19			0.46
0.45							-8	0	12	14	18	18	19			0.45
0.44								0	12	15	17	16	19			0.44
0.43								0	12	15	15	13	18			0.43
0.42								0	11	15	1	9	18			0.42
0.41								0	10	15	-2	8	18			0.41
0.40								0	9	14		7	18			0.40
0.39								0	8	13		6	18			0.39
0.38								0	7	12		6	18			0.38
0.37								0	7	12		5	17			0.37

S-time-distance: (-) time lead, (+) time lag from benchmark China

Source: Own calculations based on data from Human Development Report 2010, UNDP, Statistical Annex, Table 2, p. 151

Example 2. Life expectancy between countries in the group of very high human development and comparison with Korea

Life expectancy indicator was selected for the second example: it is an important indicator by itself and also an important element of the composite indicators like HDI or SOFI. Thus it could be also an exampleof many other independent indicators which can be presented and analysed with the time distance method. Analysis of such indicator as life expectancy (LEXP) is here demonstrated only for the HDI group of very high human development due to lack of space.

The time matrix in Table 5 visually shows that there are large differences in life expectancy even within very high human development group, e.g. of about 10 years from Japan at 83 years of life expectancy to 73 years in Hungary and Estonia. As earlier we can immediately observe the number of step of increase of life expectancy, the highest observed are 14 steps for Korea and 10 steps for United Arab Emirates. Until 2000 the values in the database were presented only in 5 year intervals, which mean that for the intermediate years interpolation was used.

Table 5. *Time matrix: time when a given indicator level was attained*
A quick visual overview over countries of very high human development group (trends 1980-2010)

HDI	LEXP Level	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
11	Japan												1983	1986	1990	1995	1999	2002	**2009**
21	Hong Kong, China (SAR)										1982	1986	1990	1992	1995	1998	2001	**2006**	
13	Switzerland											1981	1986	1992	1996	2000	2004	**2009**	
17	Iceland												1983	1989	1996	1999	2003	**2009**	
2	Australia										1982	1986	1990	1994	1997	2001	**2005**		
23	Italy										1983	1987	1991	1995	1998	2002	**2006**		
14	France										1984	1988	1992	1996	2000	2004	**2007**		
9	Sweden											1981	1986	1991	1996	2002	**2008**		
20	Spain											1984	1990	1995	1999	2004	**2008**		
15	Israel									1981	1985	1989	1993	1996	2000	2004	**2009**		
8	Canada											1983	1988	1993	1999	2003	**2010**		
1	Norway											1983	1991	1996	2001	2005	**2010**		
30	Andorra										1981	1986	1993	1997	2000	**2004**			
3	New Zealand									1985	1989	1992	1995	1999	2002	**2006**			
27	Singapore							1983	1986	1988	1990	1993	1996	2000	2003	**2006**			
25	Austria								1982	1985	1988	1992	1996	2000	2003	**2008**			
7	Netherlands											1982	1990	1998	2004	**2008**			
5	Ireland								1982	1986	1990	1996	2000	2003	2005	**2008**			
10	Germany									1984	1988	1992	1996	2000	2004	**2008**			
18	Belgium									1982	1986	1990	1995	2001	2005	**2009**			
16	Finland									1984	1989	1993	1997	2001	2005	**2010**			
33	Malta								1980	1984	1988	1991	1996	2000	2004	**2010**			
35	Cyprus										1982	1987	1993	1998	**2002**				
26	United Kingdom									1983	1987	1991	1996	2001	**2005**				
6	Liechtenstein									1982	1985	1990	1994	1999	**2005**				
24	Luxembourg								1982	1987	1990	1993	1997	2001	**2005**				
12	Korea (Republic of)	1981	1983	1985	1986	1988	1989	1992	1994	1996	1998	2000	2002	2004	**2006**				
4	United States									1981	1988	1993	1996	2000	**2006**				
22	Greece										1982	1985	1989	2002	**2007**				
40	Portugal							1982	1985	1989	1994	1997	2001	2004	**2009**				
19	Denmark										1990	1997	2001	**2006**					
29	Slovenia							1986	1990	1994	1997	2001	2004	**2007**					
32	United Arab Emirates			1981	1983	1985	1987	1989	1991	1993	1995	1999	**2005**						
37	Brunei Darussalam						1981	1984	1987	1991	1995	2000	**2007**						
42	Barbados								1983	1987	1995	2003	**2007**						
28	Czech Republic						1984	1990	1993	1996	2000	**2005**							
39	Bahrain			1981	1983	1985	1988	1991	1994	1998	2004	**2010**							
41	Poland						1988	1994	1998	2001	2004	**2010**							
38	Qatar		1983	1986	1990	1992	1995	1997	2000	2002	**2005**								
31	Slovakia						1986	1993	1998	2004	**2009**								
36	Hungary					1995	1998	2001	**2005**										
34	Estonia				1996	1999	2002	2004	**2007**										

Source: Own calculations based on data from 2010 Report, file HDI Trends 1980-2010.xls, http://hdr.undp.org/en/statistics/hdi/

The time needed in the past to increase life expectancy by one year is presented in the S-time-

step matrix in Table 6. It can be observed that S-time-step measure can be usefully compared also between indicators. Here we see that for 42 countries in the very high human development group the unweighted average of S-time-step is 4.3 years. In the earlier section the average value of S-time-step for HDI for the very high human development group was 2.3 years. In discussing dynamics of development in different fields S-time-step could serve as an easily understandable measure in the debate.

Table 6. *S-time-step: how many years were needed to reach the next level of life expectancy*
A quick visual overview of dynamics over countries of very high human development group (trends 1980-2010)

HDI	LEXP Level	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
11	Japan												3.3	4.0	5.2	3.6	3.8	6.7
21	Hong Kong, China (SAR)										4.0	3.9	2.6	2.5	2.9	3.0	5.0	
13	Switzerland											4.6	5.5	4.9	3.6	3.6	5.0	
17	Iceland												5.9	6.7	3.9	3.3	6.7	
2	Australia										3.9	4.0	3.6	3.5	3.4	3.9		
23	Italy										3.6	3.9	4.3	3.4	3.4	4.5		
14	France										3.9	4.0	4.3	4.5	3.4	3.2		
9	Sweden											4.6	5.1	5.4	5.5	6.3		
20	Spain											6.0	4.8	4.2	4.3	4.8		
15	Israel									4.0	4.1	3.8	3.7	3.5	3.8	5.2		
8	Canada											4.3	5.6	5.4	4.9	6.3		
1	Norway											7.6	5.2	4.9	3.9	5.0		
30	Andorra										5.5	6.6	4.3	3.3	3.5			
3	New Zealand									4.4	3.5	3.1	3.1	3.2	4.4			
27	Singapore							3.1	2.2	2.2	2.8	3.2	3.9	2.9	3.2			
25	Austria								3.4	3.0	3.4	4.1	4.0	3.6	4.5			
7	Netherlands											8.3	8.4	5.2	4.3			
5	Ireland								4.1	4.2	5.9	4.3	2.5	2.3	3.1			
10	Germany									4.3	4.3	4.2	3.9	3.4	4.9			
18	Belgium									3.4	3.9	5.5	5.9	4.1	3.5			
16	Finland									5.1	4.4	4.1	4.0	3.7	4.4			
33	Malta								3.5	3.6	3.8	4.3	4.1	4.1	5.9			
35	Cyprus										4.7	5.5	5.0	4.8				
26	United Kingdom									4.3	4.2	4.6	4.8	4.4				
6	Liechtenstein									3.9	4.2	4.6	4.8	6.4				
24	Luxembourg								4.2	3.5	3.1	3.5	4.4	4.4				
12	Korea (Republic of)	2.0	2.0	1.7	1.6	1.6	2.1	2.3	2.2	2.1	2.1	1.7	1.9	2.5				
4	United States									7.4	4.8	3.6	3.7	6.5				
22	Greece										3.2	4.4	12.8	4.4				
40	Portugal							2.7	4.3	4.8	3.7	3.3	3.6	5.0				
19	Denmark										7.3	4.5	4.5					
29	Slovenia							3.7	3.9	3.6	3.5	2.9	2.9					
32	United Arab Emirates			2.0	2.0	2.0	2.0	2.0	2.1	2.3	3.3	5.9						
37	Brunei Darussalam						2.7	3.2	3.7	4.4	5.4	6.3						
42	Barbados								3.9	7.9	8.0	4.0						
28	Czech Republic						5.4	3.2	3.3	3.9	5.3							
39	Bahrain			1.9	1.9	2.9	2.9	3.1	4.2	5.5	6.2							
41	Poland						6.8	3.2	3.0	3.5	5.8							
38	Qatar		3.2	3.7	2.8	2.7	2.2	2.2	2.4	3.0								
31	Slovakia						6.1	5.8	5.2	5.7								
36	Hungary					3.3	3.2	4.2										
34	Estonia				2.8	2.8	2.7	3.0										

Source: Own calculations based on data from 2010 Report, file HDI Trends 1980-2010.xls, http://hdr.undp.org/en/statistics/hdi/

The best performer in this group over the 3 decades was Korea with the average value of S-time-step of 2 years. In other words in the past Korea needed 2 years on the average to increase life expectancy by one year. Even with this very good performance the level of life expectancy in Korea is still below the average for the very high human development group. But it already managed to arrive approximately to the level of life expectancy of Cyprus, United Kingdom, Liechtenstein, Luxembourg, United States, Greece and Portugal.

Table 7 presents an example how in addition to the S-time-matrix and S-time-step one could calculate also S-time-distances for those levels which are touched by a country that went through a considerable number of steps.

Table 7. *S-time-distance in years*
(-) time lead, (+) time lag from benchmark Korea for a given level of life expectancy

HDI	LEXP Level	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
11	Japan												-19	-18	-16				
21	Hong Kong, China (SAR)										-16	-14	-12	-11	-11				
13	Switzerland											-19	-16	-12	-10				
17	Iceland												-19	-15	-11				
2	Australia										-16	-14	-11	-10	-9				
23	Italy										-15	-13	-11	-9	-8				
14	France										-14	-13	-10	-8	-6				
9	Sweden											-19	-16	-13	-10				
20	Spain											-16	-12	-9	-7				
15	Israel									-15	-13	-11	-9	-7	-6				
8	Canada											-17	-14	-10	-8				
1	Norway											-17	-11	-8	-5				
30	Andorra										-17	-14	-9	-7	-6				
3	New Zealand									-11	-9	-8	-6	-5	-5				
27	Singapore							-9	-8	-8	-8	-7	-6	-3	-3				
25	Austria								-12	-11	-10	-9	-6	-4	-3				
7	Netherlands											-18	-12	-5	-3				
5	Ireland								-12	-10	-8	-4	-1	-1	-1				
10	Germany									-12	-10	-8	-6	-4	-3				
18	Belgium									-14	-12	-10	-6	-2	-1				
16	Finland									-12	-9	-7	-4	-2	-1				
33	Malta								-13	-12	-11	-9	-6	-4	-2				
35	Cyprus										-16	-13	-9	-6	-4				
26	United Kingdom									-13	-11	-9	-6	-3	-1				
6	Liechtenstein									-14	-13	-11	-8	-5	-1				
24	Luxembourg								-11	-9	-8	-7	-5	-3	-1				
12	Korea (Republic of)	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4	United States									-15	-10	-7	-5	-4	0				
22	Greece										-16	-15	-12	-2	0				
40	Portugal							-9	-9	-7	-4	-3	-1	1	3				
19	Denmark										-9	-3	-1	2					
29	Slovenia							-6	-4	-2	-1	1	2	3					
32	United Arab Emirates			-4	-3	-3	-3	-3	-3	-3	-3	-1	3						
37	Brunei Darussalam						-8	-8	-7	-5	-3	0	5						
42	Barbados								-11	-9	-3	3	5						
28	Czech Republic						-5	-2	-1	0	2	5							
39	Bahrain			-3	-3	-3	-2	-1	0	2	6	10							
41	Poland						-2	3	4	5	6	10							
38	Qatar		0	1	3	5	6	6	6	6	7								
31	Slovakia						-3	1	5	8	11								
36	Hungary					7	9	10	12										
34	Estonia				10	11	12	13	13										

S-time-distance: (-) time lead, (+) time lag from benchmark Korea

Source: Own calculations based on data from 2010 Report, file HDI Trends 1980-2010.xls, http://hdr.undp.org/en/statistics/hdi/

For life expectancy Korea went through 14 steps from life expectancy of 66 to 79 years. Korea was able to diminish the S-time-distance lag behind the more developed countries.

Such analysis could be done also for other indicators in other indicator databases like UN, UNDP, OECD, Eurostat, ITU or the SOFI selection, though it would entail substantial amount of work. Time matrices and S-time-steps can be prepared for many indicators as they depend only on the levels of the indicators. The evaluation of S-time-distance depends also on the selection of the benchmark and the range of change of the benchmark and the length of its series in the past. If one were interested in long historical analysis it would be possible to evaluate the time distance lag of many countries if the time series for a selected indicator for some leading countries could be extended to more years in the past.

Example 3. Compressed presentation of analysis and projections over 100 years (1950-2050) for elderly population for OECD countries

The third example uses the percentage of the population of a country that is classed as elderly. Only OECD countries are used in this example which shows how time distance methodology could be used to describe various scenarios or projections. This example also illustrates the important distinction between backward looking (*ex post*) and forward looking (*ex ante*) S-time-distances. They relate to different periods, past and future. In general 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 time matrix in Table 8 also demonstrates the time distance methodology as an additional way of presentation across many units and many years enabling numerous comparisons between countries and over time. One of these characteristics is the possibility to compressing some time series data tables into a much smaller tables while still preserving the main essence of the information.

Table 8. *Elderly population (aged 65 and over; as a percentage of total population, with OECD projections)*

Level	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
Japan		1962	1976	1984	1990	1994	1998	2001	2005	2008	2012	2014	2017	2023	2031	2036	2039	2044
Korea	1983	1996	2002	2007	2013	2017	2021	2023	2025	2027	2030	2032	2035	2037	2039	2043	2046	2050
Spain			1957	1973	1985	1991	1997	2013	2020	2025	2028	2032	2035	2038	2041	2044		
Italy				1965	1975	1988	1993	1999	2007	2015	2022	2028	2031	2035	2040			
Greece			1959	1969	1974	1991	1998	2004	2015	2022	2028	2033	2037	2041	2047			
Germany				1952	1963	1972	1999	2004	2008	2018	2023	2027	2030	2034				
Portugal			1962	1975	1986	1992	1999	2013	2020	2026	2030	2035	2040	2044				
Czech Republic				1963	1987	2004	2011	2015	2020	2028	2035	2039	2042	2046				
Slovenia			1961	1971	1993	2000	2008	2015	2019	2024	2029	2035	2042	2049				
Slovak Republic			1965	1988	2007	2014	2018	2021	2026	2032	2038	2042	2046	2050				
Poland		1962	1969	1990	1999	2012	2016	2019	2023	2027	2037	2043	2047					
Finland			1965	1973	1980	1994	2005	2011	2014	2018	2023	2029						
Belgium					1960	1986	1996	2012	2018	2023	2028	2033						
Switzerland				1958	1973	1984	2006	2013	2019	2025	2030	2035						
Austria					1959	1970	2005	2014	2022	2027	2031	2038						
Hungary			1952	1964	1972	1994	2007	2015	2020	2034	2040	2045						
France					1964	1990	2000	2014	2019	2026	2032	2046						
Denmark				1957	1969	1978	2008	2012	2017	2024	2030	2047						
New Zealand				1982	2005	2012	2017	2022	2026	2030	2036	2047						
Canada			1971	1984	1995	2010	2015	2020	2024	2028	2034	2048						
Ireland					2010	2017	2023	2029	2034	2039	2044	2049						
Australia				1983	1996	2009	2014	2019	2024	2029	2037							
Sweden					1962	1971	1979	2009	2014	2026	2042							
Netherlands			1952	1969	1985	2004	2011	2015	2021	2026	2047							
United Kingdom					1964	1975	2007	2015	2024	2030	2049							
Estonia					1991	1996	2003	2017	2026	2040	2050							
Norway				1954	1965	1977	2013	2020	2028	2035								
Luxembourg				1951	1967	2007	2018	2025	2030	2037								
Chile		1988	2005	2013	2020	2024	2028	2033	2039	2050								
Iceland			1959	1983	2008	2016	2021	2026	2033									
United States				1972	1986	2014	2020	2025	2045									
Mexico	1969	2011	2020	2026	2030	2035	2039	2043	2047									
Israel	1950	1966	1976	2008	2017	2026	2037	2045										
Turkey	1965	2007	2021	2029	2035	2040	2045											
OECD total			1953	1974	1992	2006	2014	2020	2026	2032	2039							
World		1989	2014	2023	2031	2039	2049											
EU27 total				1961	1972	1991	2002	2012	2018	2024	2029	2034	2042					

Periods:

1950-2010	2011-2030	2031-2050

Own calculations based on data from OECD Factbook 2010

This level-time table-graph covers the period of 100 years, 40 years of which are OECD projections in the Factbook 2010. It is difficult to imagine that the usual table of 34 countries across 100 years with 3400 entries would allow such a compressed essence of the long-term information and visualization for relevant perception of the situation.

The countries are sorted by the expected positions in the last projection decade. Ten countries are expected to have 30 percent or more of population aged 65 years or more, led by Japan and Korea, followed by Spain, Italy and Greece.

Conclusions

The analysis techniques described here are not forecasting tools in themselves but provide a means of presentation of complex data sets that have universal appeal, are intuitively understandable and can be usefully applied to a wide variety of substantive fields at macro and micro levels. They are a new way of presenting and analysing indicators complementing and not replacing existing methods.

The three empirical examples discussed confirm that the time distance perspective brings additional insight and new semantics to the analysis of the disparities in a dynamic framework and to the policy debate. The two generic statistical measures S-time-distance and S-time-step are expressed in time units, which make them intuitively understandable by policymakers, professionals, managers, media and the general public. S-time-distance and S-time-step have, in addition to their use as descriptive statistical measures, the potential to provide new insights from existing data for a variety of situations in economics, management, research and statistics, asking new questions, formulating new hypotheses, establishing new semantics and reaching new conclusions.

Existing time series data are transformed into time matrixes which provide (with some interpolation) a visual impression of both levels of the indicator and the number of steps experienced over time. In addition, each selected level is related to the time when it was achieved. The two statistical measures S-time-distance and S-time-step with clear interpretability can be calculated from such time matrix. Even without calculations, the matrixes can be used in publications, web pages and other software as one of the easily understandable first level visualization; they help ‘Turn Statistics into Knowledge’. There is a wealth of information and of possible comparisons in these tables as shown briefly in the empirical examples.

The identifiers in such level-time matrix are units and selected levels of the variable while the corresponding times are in the main body of the table. Calculating these times by interpolations may pose a problem in achieving a level of accuracy commensurate with the original data but it can provide additional understanding about time dimension of disparities.

Such analysis could be done also for selected time series of numerous indicators in the respective databases from UN, UNDP, OECD, Eurostat, ITU, the SOFI,or business data. We intend to test and apply it to SOFI data, for describing and comparing systemic SOFI over many units and many years, describing and comparing various scenarios also with time distance measures, and for monitoring. From the theoretical notion of time distance it may be

possible to develop it also as a measure of goodness-of-fit, in stochastic models (e.g. criterion for evaluating forecasting models (Granger and Jeon, 2003)) and for extension of decision making models.

One of such interesting application not discussed in this chapter is using S-time-distance as the second dimension in monitoring implementation of targets at macro and at business levels (Sicherl 2008). The time distance information seems to be at least as helpful in providing a proper perception of the progress in implementation or the lack of it as is the percentage difference. SICENTER developed a free web tool which allows a variety of interested users such as international and national organizations, NGOs, experts, managers, educators, students and media to monitor with S-time-distance the lead or lag in time for the UN Millennium Development Goals, the Lisbon and NRP targets in the case of EU and or other planned, budget, or aid disbursement targets at world, regional, national, sub-national and business levels[3]. The tool is available at http://www.gaptimer.eu/s-t-d_monitoring_tool.html

Due to lack of space we cannot present the time distance results undertaken for 169 countries for HDI and life expectancy. Therefore we concentrated on disparities between development groups, world regions and China for the former and for 42 countries in the very high human development group and Korea for the latter. The disparities in the HDI in the world are very large; the time matrix visualization shows that at a glance and allows also estimating the time distance dimension of disparities. As mentioned earlier, different measures provide very different perceptions of the order of magnitude of disparities. Static disparities in HDI appeared small and time distances in HDI were large; both need to be taken into account to understand the reality better.

A very important theoretical and practical question is how to treat and interpret intertemporal changes in composite indicators. S-time-step is a new complementary measure of the dynamics of the indicator for a given unit that is very easy to understand. The average value of S-time-step for HDI for the very high human development group was 2.3 years, for life expectancy for this group the unweighted average of S-time-step was 4.3 years. This means that in the past 2.3 years or 4.3 years were needed for one step higher value of the HDI or for one year higher life expectancy, respectively.

The example of the elderly population for OECD countries with projections shows how time distance methodology could be used also for describing various scenarios or projections. There is important distinction between backward looking (*ex post*) and forward looking (*ex ante*) S-time-distances. They relate to different periods, past and future. In general 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. This time matrix covers the period of 100 years and represents compressed essence of the long-term information and visualization for relevant perception of the situation in one table describing the increase in levels of the share of the elderly population in 34 countries.

Time distance perspective allows stakeholders to see the situation with new eyes, which creates new knowledge and better understanding of reality and future possibilities.

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Notes

[1] 'As Sicherl … proposes ... observed time distance is a dynamic measure of temporal disparity between the two series intuitively clear, readily measurable, and in transparent units….. It is suggested that one should complement conventional vertical measures with horizontal measures' (Granger and Jeon 1997).

[2] For details see Sicherl (2002), also on possible multiple time intersections.

[3] The free web tool allows the user to track the implementation of targets by using his/her choice of data and assumptions. It may be that some politicians, some organisations and some experts might not like the additional information on the implementation of targets as it is giving a clear message understandable to everybody. But for the media, NGOs, independent experts and international organisations the transparency provided can be helpful for strengthening the democratic debate.