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RESEARCH ARTICLE

S-TIME-DISTANCE – DUAL PARALLEL SYSTEM FOR ANALYSING INDICATORS EXAMPLE OF GENDER DIFFERENCES IN LIFE EXPECTANCY IN THE WORLD.

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Abstract

The S-time-distance method enables two-dimensional analysis of disparities in time series indicators: distance in time for a given level of the variable is complementing prevailing static distance at a given point of time. Expressed in time units it is intuitively understandable to everybody and comparable across variables, fields of concern and units of comparison. We need new data and indicators, but we also need innovative concepts of looking at data and new generic statistical measures to better perceive and exploit the information available in existing data. It is recommended that for time series analysis in many fields S-time-distance may be tested to provide new insight from existing data. Two generic statistical measures, S-time-distance and S-time-step, S-time-matrix and novel application for monitoring implementation of targets are discussed and demonstrated on the example of gender differences in life expectancy at birth in the world. The degree of disparity may be very different in static terms and in S-time-distance; for gender disparity in life expectancy in EU static index is less than 7 percent while S-time-distance amounts to 26 years – a very different perception of the divide. Comparing four indicators for 200 countries, for life expectancy and obesity prevalence women consistently show higher values, men lag them in about 100 countries for more than 20 years. For mean BMI gender differences are more balanced, while for diabetes prevalence the situation is different, incidence for men is ahead of women, in 34 countries men are ahead of women for more than 20 years.

Introduction:-

At the theoretical level the S-time-distance methodology adds innovative dual parallel generic system for analyzing indicators in the parallel universe of time beyond the static differences, adding new vocabulary and not replacing the current methods. In analysis of time series indicators differences between two (or more) time series can and should be compared in both dimensions of the scatter diagram with axis of the selected variable Y and time X, vertically and horizontally. This idea led to the introduction of the S-time-distance concept as a measure of disparities in economic and social development (Sicherl, 1973) but has over the years evolved towards a much more general approach. The approach is universal, results expressed in time units are easily understandable by everyone, and applicable to a wide variety of fields at both the macro and micro levels. Since S-time-distance view provides an

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additional dimension of temporal disparity, results by other methods are left unchanged but new conclusions can be reached in a broader theoretical and statistical framework. In the section Method two generic statistical measures, S-time-distance and S-time-step, as well as S-time-matrix and novel application for monitoring implementation of targets are elaborated.

S-time-distance methodology is a generic methodology, applicable to numerous domains beyond gender disparity and numerous time series indicators beyond the selected indicators here. J. Backhouse of LSE commented that as time distance is a generic concept, and as it has been the case e.g. with spreadsheet, one cannot in advance specify all the uses to which a generic framework can be put to imaginative users in numerous fields. On the scientific side, the fact that the Nobel Prize winner C. W. J. Granger extended the use of S-time-distance measure to econometric forecasting is an evidence of the generic capability of the idea. "As Sicherl (1973, 1993) proposes… Observed time distance is a dynamic measure of temporal disparity between the two series, intuitively clear, readily measurable, and in transparent units which are comparable across a pairing of indicators and indicated variables. It is suggested that one should complement conventional vertical measures with horizontal measures." (Granger C W. J. and Jeon Y., 1997).

Resources for the study of gender differences over long period of time were possible for life expectancy with UN data for quite some time but the extension to body mass index and diabetes was made available by two studies in Lancet: the study of trends in adult body-mass index (NCD Risk Factor Collaboration; NCD-RisC, 2016a) and the study on diabetes (NCD-RisC, 2016b) (and with more details on www.ncdrisc.org). These and some other data provided by the Institute of Health Metrics and Evaluation (IHME) were the resource over the long-time horizon at disaggregated gender level that made it possible that S-time-distance framework could examine the astonishing magnitudes of time gaps for gender difference in either directions. IHME also used the time distance concept to analyse the lag of the US counties for life expectancy behind an international context (Kulkarni et al., 2011).

Procedure for calculating S-time-distances may be as follows. For each country three time series of data are ordered: time, female and male life expectancy. For each year one takes the value of male life expectancy for a given year, searches the series of female life expectancy and determines in which year the value of the comparing male life expectancy was attained, and subtracts the respective two times. If time series are ordered vertically, this means vertical look-up procedure; if horizontally, then horizontal look-up procedure. For large time series it is useful to prepare software tool for such procedure.

Another resource for long-term S-time-distance analysis was the database from International Telecommunication Union (ITU). In the Measuring the Information Society 2010 report in the section on time distance analysis ITU and SICENTER established the time lead or time lag behind Sweden for about 200 individual economies for mobile cellular penetration. It was also established that for the average of developing countries the lag for mobile cellular penetration rate behind Sweden was because the very high dynamics less than 10 years while for life expectancy it was more than 60 years (ITU, 2010). Furthermore, the resource for a shorter time span was the database for Millennium Development Goals (MDGs) implementation (UN 2014, 2015a, 2015b, 2015c).

Method:-

S-time-distance methodology

Events are dated in time, therefore in time series comparisons the notion of time distance was always there as a "hidden" dimension. What was needed was to systematise and formalise the approach and define an appropriate statistical measure for operational use.

A broader theoretical framework is needed. The conventional approach does not realise that in addition to the disparity (difference, distance) in the indicator space at a given point in time, in principle there exist a theoretically equally universal disparity (difference, distance) in time when a certain level of the indicator is attained by the two compared units. It follows that S-time-distance has an important role to play in complementing the conventional static perception and measures of disparity. The perception of and the conclusions about the degree of disparity based on two-dimensional analysis of proximity provide a better understanding of the situation; a new dimension is added while no earlier results are lost or replaced.

Time distance in general means the difference in time when two events occurred, and the concept is applied in many fields. In our case, for analysis of time series indicators, a special category of time distance S-time-distance is defined, which 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.) is used as a dynamic (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 (Sicherl 2011a, 2011b, 2004).

Fig. 1 of female and male life expectancy for the EU demonstrates the salient point of the article that time series could and should be compared in two dimensions:

1. Static gap for a given point in time, and
2. Gap in time for a given level of the variable.

In other words, while most of the analysis of disparities are based on static analysis, it is obvious that for time series indicators differences between two (or more) time series can and should be compared in both dimensions of the scatter diagram with axis of the selected variable Y and time X, vertically and horizontally. The only question is: why not? Why not experimenting out of the box? Is there a limiting belief that static analysis in disparity and inequality field is good enough and that it fully exploits the information available in database? Technically, why gaps between two or more time series are not studied in both directions (dimensions)? An additional view of existing databases can provide better utilisation of information content and derive new insights from existing data.

Time has until now been used in comparisons mainly as location information, i.e.as a coordinate in a parameter frame forming a coordinate system that is used to organise (or index) a set of variables. In other words, it has played the role of a descriptor, subscript or identifier. The new S-time-distance approach offers new avenues for detecting additional information content, without replacing the existing views. If we choose to interchange in the time series database the roles of the level of the variable and of time, the 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.

Developing the horizontal perspective in the time series context two generic statistical measures were established:

Sicherl-time-distance as a special category of time distance related to the defined level of the variable: (S-time-distance in short, SLTD, level time distance)

For a given level of X_L, $X_L = X_i(t_i) = X_j(t_j)$, the time span separating unit (i) and unit (j) for the level of variable X_L will be written as

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

Three subscripts are used to indicate the specific value of S-distance: (1 and 2) between which two units is the time distance measured and (3) for which level of the indicator (in the same way as the time subscript is used to identify the static measures). In some cases also the fourth subscript may be necessary to indicate to which point in time it is related.

Sicherl-time-step (in short S-time-step, SLTS, level time step)

The S-time-step measures the time elapsed between two levels of a single time series, providing an alternative description of its growth rate, measuring the growth of a series by using the inverse relation to the conventional $\Delta X/\Delta t$ growth rate metrics. For instance, as shown in Table 1 for the EU that the average female life expectancy needed in the past about 6 years, and male life expectancy 5 years, to increase the life expectancy for one year from 79 to 80 years for females, and from 77 to 78 years for males. This is a complementary description of the dynamics of life expectancy to the conventional growth rate value of about 0.2 percentage per year. Both measures are valid description of the dynamics of change, while for general public S-time-step might be even easier to understand and perceive. S-time-step is expressed in units of time and is defined as:

$$S_i\,(\Delta X_L) = [t_i\,(X_L+\Delta X) - t_i\,(X_L)]/\Delta X \qquad (2)$$

The simple example of visualisation of time series indicators and measures is illustrated in Fig. 1. The difference between female and male life expectancy for EU28 in 2015 is estimated at 5.4 years. This absolute measure of gender differences for the value of life expectancy of 77.9 years for male average in 2015 is the first and easy understandable perception of the disparity between sexes in this indicator. This may also be expressed in index or percentage.

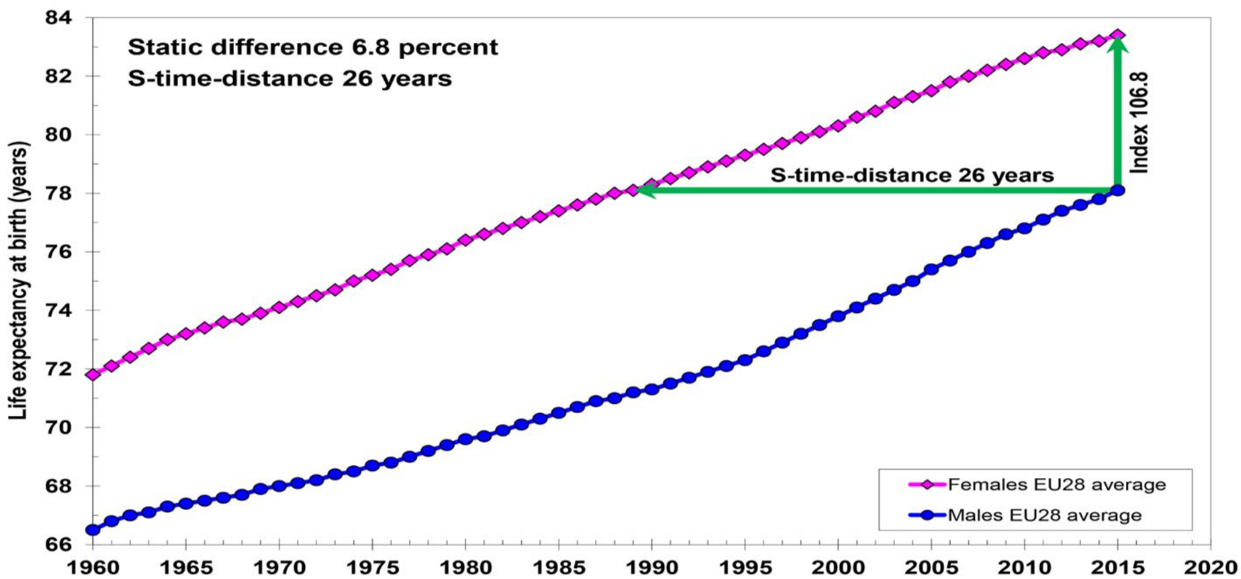

Figure 1: Gender disparities in life expectancy at birth, EU28 average in 2015: static index and S-time-distance. Source: Own calculations based on Eurostat database (Eurostat, 2018).

Another dimension of the degree of disparity is the distance in years when men and women reached the same reference level of the variable. Namely, at the same time with these static measures the horizontal observation for the 2015 male level of 77.9 years can be compared to the time when the same absolute level of life expectancy was attained for female average. This was in 1998. S-time-distance for average for males of 77.9 in 2015 amounts to 26 years (2015 - 1998 = 26 years). The specification of the direction of the comparison depends on the sign of the distance: (+) plus denotes the lag in time of the lower unit behind the upper unit, (-) minus sign indicates the lead in time of the upper unit time ahead of the lower unit.

The example shows that perceptions of the size of this gap can be very different depending on the statistical measure used. Here the static difference between two lines in 2015 is less than 7 percent (which may appear to be small), while the S-time-distance is 26 years (which gives a very different perception of the magnitude of the gap). For realistic evaluation of the situation we need both measures. The examples of S-time distances for 200 countries for life expectancy are shown in Table 4 and for obesity prevalence, mean BMI and diabetes prevalence in Table 5.

Sicherl-time-matrix (STM) is a tool that provides a table-graph format which is defined by levels of the variable and derives times when such variables were attained. One problem with the conventional tabular presentation of time series data is that the full matrix cannot be easily presented when these data span very long periods. Hence, STM presents a more parsimonious way to available evidence. The conventional table-format for time-series data is transformed into S-time matrix, which has a table-graph format. The identifiers in level-time matrix are selected levels of the variable for units while the corresponding times are in the main body of the table. Calculating these times by interpolations may pose a small problem of the degree of accuracy compared to larger table of original data but it gains additional understanding about time dimension of disparities and a good summary overview. Computer software Time Matrix Calculator was developed by Faculty of Social Sciences, University of Ljubljana and SICENTER, Ljubljana, Slovenia to enable users to calculate time matrix from their own data and specification and is available on www.timedistance.net.

Table 1 is a simple example of S-time-matrix for four time series for the period 1960-2016 for females and males for Sweden and EU28. The usual table in the database would entail 230 fields. Here S-time-matrix is defined for years of life expectancy for 18 values of the variable, i.e. for values of life expectancy from 67 years to 84 years, which requires only 90 fields. It is like turning around the Rubik cube, transforming detailed data on values of life expectancy into times when certain values of life expectancies were attained by analysed countries. The times returned could be also in months (Sicherl, 2005) or days or seconds in some experiments. Study EU at a Glance (Sicherl, 2014c) presents S-time-matrix overview of 30 selected indicators over 28 EU countries over time, which is probably the most condensed summary picture of disparities and dynamics of EU countries over many domains over time.

The S-time-matrix enables quick overview of the past trends and relations. The first two rows compare females and males for Sweden, women reached life expectancy of about 84 years, men about 80 years. So, for Sweden for level of 80 years the S-time-distance lag was 24 years, lag for men or lead for women (2012-1988). The last two rows show results for females and males for EU aggregate, females reached life expectancy of 83 years, and men 78 years, a difference of about 5 years. In both cases perception of the degree of gender differences is much large measured by S-time-distance of about 27 years (i.e.a quarter of the century, 2015-1988) as compared with static difference of about 5 years in the value of the variable.

Below the time matrix there are two examples how one could from the time matrix derive approximate magnitudes of disparities between countries in S-time-distances. For the values of live expectancy that were reached in all compared countries, one can by subtracting the times in the matrix by the time of the selected benchmark (which in this case is males in the EU) and get respective S-time-distances. The figures approximate time lag of the average for males in the EU from values of life expectancy of 72 years to 78 years. Over time there were changes in the values of S-time-lag but, broadly speaking, differences between life expectancy from EU males are clear: the time lag behind females in the EU is about 27 years, behind males in Sweden 12 years, and behind females in Sweden even around 40 years.

Table 1:-Sicherl time matrix.

Sicherl time matrix for male and female life expectancy for EU and Sweden																		
LEVEL	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**
F Sweden									1960	1965	1970	1976	1981	1988	1993	2000	2006	**2014**
M Sweden						1972	1981	1986	1991	1994	1999	2003	2007	**2012**				
F EU28							1964	1970	1974	1979	1983	1988	1994	1999	2003	2006	**2012**	
M EU28	1963	1971	1979	1983	1987	1993	1997	2000	2004	2007	2010	**2015**						
Derived estimates of S-time-distances from benchmark life expectancy for males in EU (years)																		
F Sweden									44	42	40	39						
M Sweden						21	16	14	13	13	11	12						
F EU28							33	30	30	28	27	27						
M EU28						0	0	0	0	0	0	0						
Estimates of Sicherl time step for increase in life expectancy of one year (in years)																		
F Sweden										5	5	6	5	7	5	7	6	8
M Sweden							9	5	5	3	5	4	4	5				
F EU28								6	4	5	4	5	6	5	4	3	6	
M EU28		8	8	4	4	6	4	3	4	3	3	5						

Source: Own calculations based on data from Eurostat (Eurostat, 2018).

Below that calculations there is an example how from the times in the S-time-matrix it is possible to calculate estimates of S-time-step elaborated earlier. It shows how much time was needed to increase 1 year of life expectancy. For instance, it took 8 years to increase the value of female in Sweden from 83 to 84 years (2014-2006) or 6 years for females in EU from 82 to 83 years (2012-2006); this is a possible additional way to evaluate dynamics of the indicator in addition to the rate of growth measure.

With these three additional tools, two generic statistical measures and time matrix tabulation, it is possible to get from existing time series databases a new perspective related to time. i.e. new insights from existing data in units of time which is understood by everybody.

S-time-distance monitoring of implementation of targets

There are many possible applications of S-time-distance methodology, some of them are available on www.gaptimer.eu. In this section the attention is brought to a line of applications that is very practical in very broad set of situations where targets, benchmarks, projections and hypotheses are compared with actual values and are formed as differences between two time series. Again, the two relevant time series of expected and actual values over time are compared vertically and horizontally in Figure 2.

Figure 2 deals with a specific application of the time distance methodology to monitoring implementation of MDG targets (Sicherl 2015), and more generally to comparing actual values with target values, forecasts, budgets, scenarios and plans.

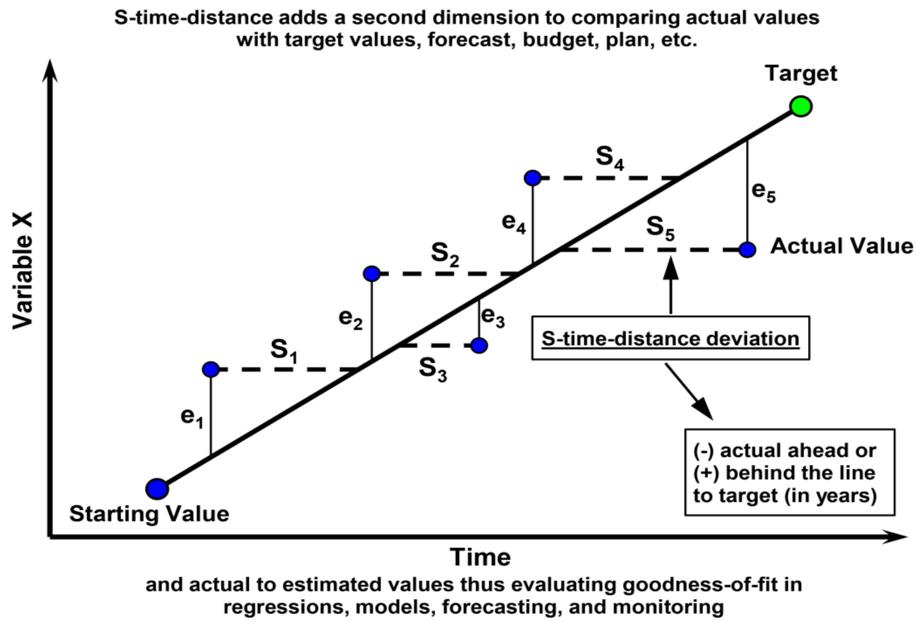

Figure 2:-Dual parallel system for implementation of targets. Source: Sicherl P. (2015), p. 43.

The round dots in the figure represent actual values at a given time and conventional static deviation from the line to target (or projection) are presented by vertical distances e_i. From each actual point it is also possible to draw horizontal line and the S-time-deviation S_i at that point will be the difference in time between the actual time and the time on the line to target for that level.

For the study for monitoring implementation of MDG targets the continuously increasing or decreasing lines to targets were appropriate. Therefore, the procedure was easy to apply to monitoring implementation of the 10 selected MDG indicators for world regions and in details for five MDG indicators for 125-154 countries (Sicherl, 2015). This application can be used again for the implementation of ongoing UN Sustainable Development Goals (SDGs), for world regions as well for individual countries of the numerous sets of indicators. Also, The National Statistical Co-ordination Board in Philippines is an example of how one policymaker in one country used the time-distance measure of MGDs implementation together with other measures (Sicherl, 2013).

In a broader context the meaning of the line to target in Figure 2 could be interchanged to represent regression line or projection so that the two-dimensional dual parallel system for analysing indicators can be extended also to evaluating goodness-of-fit in regressions, models and forecasting (Sicherl, 2011a). For more complicated cases one should consult Granger and Yeon (2003a and 2003b) for application of forecasting inflation in the USA.

Monitoring implementation of targets is an integral part of decision making at many levels and in many domains. The innovation is that implementation of targets is described in two dimensions: static deviation from the line to target at a given point in time and S-time-deviation at a given level of the indicator. Describing the implementation of targets as leading or lagging in time against the line to specified targets or projections is very useful. The characteristics that it is expressed in time units means that it is comparable across variables, fields of concern and units of comparison, which makes S- time-distance an excellent complementary analytical and presentation tool for policy, business and scientific debates. It can help us to form a new perception of the magnitude of the gap between the implementation and proclaimed targets for a given indicator as well as across more indicators.

Results:-

Overview of gender disparities in life expectancy in the world

The UN estimates show nearly unanimous conclusion that female life expectancy at birth is higher than that for males, this holds for countries including 99.5% of the world population. Without major changes in health conditions the UN estimates expect that higher female than male life expectancy at birth would prevail over the whole period of 150 years (1950-2100) (UN, 2011).

Table 2 shows the absolute value of the gender difference in life expectancy over the period of 55 years for selected regions. The gender difference is higher in more developed regions (MDR) than in the less developed regions LDR (as defined by UN DESA), of over 6 years and 3 years, respectively. This is confirmed also by comparing USA and EU28 to China and India. Whether this gender differences are large or small is a question of the subjective weights that people assign to the magnitude of such disparity.

The conclusion that the gender disparity in life expectancy is very persuasive and a long-standing phenomenon is further confirmed by introducing the S-time-distance statistical measure as another complementary perception of the degree of the female-male disparity in life expectancy. Table 3 shows this additional perspective, comparing time-series in the horizontal dimension, i.e. for a given level of the variable.

Table 2:-Gender disparities in life expectancy in years (Female minus Male).

Time	World	MDR	USA	EU28	LDR	China	India
1960	3.2	5.9	6.5	5.3	2.1	2.8	-1.5
1965	3.6	6.4	7.1	5.8	2.2	3.3	-1.4
1970	3.9	6.9	7.6	6.1	2.5	3.6	-1.1
1975	4	7.3	7.7	6.5	2.6	2.8	-0.5
1980	4.4	7.6	7.5	6.8	3	2.9	0.2
1985	4.4	7.3	7.2	6.9	3.2	3.2	0.3
1990	4.5	7.4	7	7	3.3	3.3	0.7
1995	4.7	7.7	6.4	7	3.4	3.7	1.3
2000	4.4	7.5	5.5	6.5	3.4	3.4	1.7
2005	4.3	7.3	5.1	6.1	3.3	3	1.7
2010	4.5	6.7	4.9	5.8	3.6	3.1	2.3
2015	4.5	6.2	4.7	5.3	3.8	3	3

Source: Based on data from UN (2015d).

Empirically, the degree of disparity may be very different in static terms and in time distance, which leads to new perceptions, conclusions and semantics important for policy considerations. For the world average S-time-distance, i.e. the horizontal gap between trends of female and male life expectancy amounts to about 14 years. This means that the male life expectancy in the 2010−2015 period was achieved by females already in the period 1995−2000. S-time-distance between levels of male life expectancy in 2015 and the trends of female was 26 years for the EU28 and around 38 years for the USA. This means that the time lag of males behind females in the USA is nearly half of the life expectancy for males; for instance, the male life expectancy in 2015 was attained by females already in 1977. In other words, during the whole period from 1977 higher values for women in the USA were prevailing without interruption in a very stable position and with very small probability of change in a foreseeable future.

Table 3:-S-time-distance (in years): Time lag for males behind females in life expectancy for a given level of males.

Time	World	MDR	USA	EU28	LDR	China	India
1960	7.5	9.8			5.2		-2.3
1965	5.7	13.1		14.7	2.3	1.8	-2.0
1970	5.1	17.5		18.3	2.8	2.2	-1.6
1975	7.4	21.7		22.0	4.5	3.4	-0.7

1980	9.6	25.7		25.2	5.8	4.9	0.3
1985	11.2	28.8	35.0	28.3	7.4	7.7	1.0
1990	13.5	32.8	37.7	31.3	9.3	11.2	1.4
1995	16.8	37.4	38.5	33.3	11.8	14.8	2.3
2000	18.0	40.8	33.5	31.5	12.7	13.5	3.6
2005	17.5	42.3	33.3	29.0	11.0	8.3	4.5
2010	14.5	38.5	35.3	28.0	10.0	10.0	5.0
2015	13.7	37.5	37.7	26.0	10.8	12.3	6.8

Source: Own calculations based on data from UN (2015d).

S-time-distance measures provide another impression about the magnitude of the degree of the gender differences in life expectancy as compared to percentage differences. For the USA and the EU the S-time-distance lags of about 38 years and 26 years, respectively, give impressions of much larger disparity than the static difference below 10 percent. Looking over a longer period the low growth rate of life expectancy indicates that this gender disparity will be very difficult to change or even eliminate, while the disparity of less than 10 percent would give a very different impression.

More detailed regional examination is made available in Table 4. After analysing gender differences by S-time-distances for each of 200 countries it is possible to systematise the results and conclude that within the very clear overall tendency there were very great differences between countries and regions. The S-time-distance results in years are ordered in two sections: male ahead of female, and male behind female. At a glance one can observe that in only two countries (in Sub-Saharan region) the life expectancy estimates at birth for males are higher than for females, for 198 countries out of 200 countries life expectancy for females is higher than for males. By counting the number of countries, this means 1 percent, in terms of population even less. Countries are then in each section ordered by the magnitude of S-time-distance disparity in classes of 10 years.

Table 4:-Results of S-time-distance gender comparisons over regions for life expectancy in 2014.

Life expectancy (years)		Number of countries									
S-time-distance (years)		All	Sub-Saharan Africa	Central Asia, Middle East and North Africa	South Asia	East and Southeast Asia	Oceania	High-income Asia Pacific	Latin America and Caribbean	High-income Western countries	Central and Eastern Europe
(-): Male ahead of female (years)	less than -40										
	from -40 to -30										
	from -30 to -20										
	from -20 to -10										
	from -10 to 0	**2**	**2**								
(+) Male behind female (years)	from 0 to 10	**55**	**40**	**2**	**6**	**4**			**2**		
	from 10 to 20	**44**	**4**	**14**		**4**	**6**	**2**	**5**	**6**	**1**
	from 20 to 30	**52**		**5**		**3**	**2**	**1**	**12**	**16**	**4**
	from 30 to 40	**23**	**1**	**2**		**4**	**1**		**9**	**3**	**2**
	more than 40	**24**	**1**	**5**					**4**		**13**
Male ahead of female <0		**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Female ahead of male >0		**198**	**46**	**28**	**6**	**15**	**9**	**3**	**32**	**25**	**20**
All		**200**	**48**	**28**	**6**	**15**	**9**	**3**	**32**	**25**	**20**

Source: Own calculations based on data from UN (2015d).

The first surprise is the large range of classes of the magnitude of S-time-distances with males behind females, and especially the large number of countries where the time lag is larger than 20 years as indicating long persistent domination in time of a particular gender. From 198 countries where life expectancy is higher for females than males there are 99 countries with S-time-distance below 20 years and 99 countries with values higher than 20 years;

in the second group 24 countries show the time lag of males greater than 40 years. Obviously, the degree of gender disparity may be very different in static terms and in time distance.

In percentage terms in 2015 the range of sex differences for 200 countries varied from -2.9 percent in Swaziland to about 15 percent for Belarus. The perception of the magnitude of sex differences is very different as S-time-distances varied from five year in favour of men in Swaziland to about 60 years! in Belarus in favour of women. We need both measures to understand the reality. Across regions for life expectancy S-time-distances of male behind female were higher than 20 years in Central and Eastern Europe, followed by Latin America and Caribbean, high income Western countries, and Central Asia, Middle East and North Africa. On the contrary, for countries in the South Asia region the S-time-distance lag did not exceed ten years. Though the S-time-distances for the past should not be taken as prediction for the future, these values indicate that the gender disparity in life expectancy is very persistent and will be in most countries very difficult to change. These measures of gender differences can be used also as dependent variable for further studies of the factors leading to these differences.

Results:

Expanding the method to obesity, mean BMI, and diabetes: are gender differences large or small?

The availability of new data of longer time series for 200 countries makes possible productive application of S-time-distance methodology for describing and analyzing differences between females and males in the parallel dimension of time. As the focus in utilising the available datasets the gender difference in these indicators were selected, which can be attractive from both the medical and social standpoint and these results can be further elaborated in much more details with additional studies. They present a very remarkable broad effort for preparing the database and analysis on these topics.

Table 5: Summary of country results for 4 indicators in 2014.

	S-time-distance (years)	Number of countries			
		Life expectancy (years)	Obesity (prevalence)	Mean BMI (kg/m2)	Diabetes (prevalence)
(-): Male ahead of female (years)	less than -40			2	21
	from -40 to -30			3	4
	from -30 to -20			15	9
	from -20 to -10		1	21	17
	from -10 to 0	2	23	20	60
(+) Male behind female (years)	from 0 to 10	55	28	34	70
	from 10 to 20	44	45	60	16
	from 20 to 30	52	74	28	3
	from 30 to 40	23	19	10	
	more than 40	24	10	7	
	Male ahead of female <0	2	24	61	111
	Female ahead of male >0	198	176	139	89
	All	200	200	200	200

Source: Own calculations based on data from UN (2015d) and NCD-RisC (2016c).

Here the results of the S-time-distance measure for 200 countries are presented to analyse how the time lead or time lag vary among four indicators: life expectancy, obesity, mean BMI and diabetes. It was observed that the number of countries where the stability of male female relationship would prevail over many years in one or the other direction is very different for the four selected indicators.

The number of countries where females are ahead of males is falling from the left to the right: life expectancy 198, obesity prevalence 176, mean BMI 139, and diabetes prevalence 89 (where the balance is turned to values for males being ahead of females). The circles in Table 5 indicate cases when the S-time-distance results show gender disparity as larger in direction of either gender for over 20 years. First two, life expectancy and obesity are tilted strongly in the direction of dominance of females being ahead of males. For obesity prevalence even 103 countries are in the category males behind females for more than 20 years.

China and India show obesity prevalence below 10 percent, while for Egypt, Turkey and South Africa the female obesity percentages are at or above 36 percent. For USA the percentage is also high at 34 percent, for United Kingdom at 28 percent. However, there is an important distinction. For USA and for the United Kingdom the obesity prevalence is high also for men so that gender time distances are only few years. For Egypt, Turkey and South Africa the time distances show large time differences of 28, 24 and more than 40 years, respectively, for higher values for women.

Gender distribution of countries for mean BMI is more balanced, yet there are tremendous differences between countries; with 45 countries S-time-distance being in the range of 20 years to more than 40 years of lag of males (like Swaziland) confronting the other group of 20 countries with values in the range – 20 years to less than -40 years, with time lead of males (like Switzerland). This is a very different perception of the gender disparities in the countries as those of percentage differences at given point in time. For the two countries mentioned the perception based on percentage differences is moderate, around 15 percent in either direction. This range of percentages does not give the impression that the gender difference would be very difficult to change over time; the time gap between genders of 40 years leads to a very different conclusion.

For diabetes the gender distribution is significantly different. The number of countries (111) with males outnumbered females for diabetes prevalence, showed a different situation than the situation for the earlier three indicators. The 34 countries showed time lead for males of more than 20 years indicating that diabetes is over a long time in these countries affecting more men than women. The diabetes data relate only to 35 years in the past.. The highest values for diabetes are happening in high income Western countries and high income Asia Pacific. For a group of these countries the S-time-distance showed that for diabetes prevalence women were experiencing lower values than men of more than 35 years.

Discussion:-

Time is besides money one of the most important reference frameworks in a modern society. Yet the existing methods in social science and statistics do not fully utilise the information content with regard to certain aspects of the time dimension that are embodied in the analysed data and could contribute to a better understanding of the disparities. This is regrettable as time is tremendously important non-material resource for individuals, communities and nations. Being available for 24 hours per day for everybody it is the most equally distributed resource in the world. Time use is important characteristics of people as consumers, producers, citizen and human beings. People understand time and feel time as being one element of their perception regarding their position to other individuals, communities, and nations in the world. Sicherl (2011a) discussed the concept of ‘overall degree of disparity’, arguing that disparities in society depend not only on static measures of inequality but also on time distances. Further discussion on inter-temporal aspect of wellbeing was in Sicherl (2007) and in Sicherl (2014a) in the Springer Encyclopedia of Quality of Life and Well-Being Research. Such a broader concept of the overall degree of disparity can lead to a different perception of the extent of disparity than the conventional static measures alone.

These notions of S-time-distance and lead or lag in time are not unknown in sports and business practice. For instance, in some sport disciplines the relations between space and time are ordered in the way that distance in space is kept constant and the results are expressed as time distances for given distance in space. In skiing the length of track is the same for all competitors; this is true also for track competition in athletics or swimming.

Being expressed in units of time make the S-time-distance and S-time-step easy understand by everybody, which is important for creating perceptions and communication. American philosopher Ken Wilber underlines that time (calendars and clocks, hours, minutes months, years) represent mental software that people can use each and every day without giving them a second thought (Wilber, 2014).

In the broader context of measuring disparities over many indicators, units of comparison and various fields of concern (for which gender differences in life expectancy is used here as an example) comparing absolute values of differences for compared units is rather difficult due to different units of indicators (life expectancy in years, weight in kg, Hertz for vibration, etc.). This is most probably one of the reasons that researchers when comparing between various indicators use percentages as the dominant statistical measure for static comparisons.

This simple example of gender differences in life expectancy demonstrates that, beside percentages, an additional generic statistical measure S-time-distance is available that can be used for comparing disparities across indicators and between fields of concern. The S-time- distance approach brings about two persuasive advantages for extensive practical use. Expressed in time units (years, minutes, seconds, etc.) it is intuitively understood by policymakers, professionals, scientists, managers, media, and the general public thus facilitating their subjective perception about the situation in the time dimension. 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.

Conclusions and Recommendations:-

1. S-time-distance and the dual parallel system for analyzing time series indicators simultaneously in vertical and horizontal dimensions established important improvement over the conventional prevailing static analysis alone. The present state-of-the art does not realise that, in addition to static comparison, there exists in principle a theoretically equally universal measure of difference (distance) in time when a given level of the variable is attained by the two compared time series. The broader framework shows that perceptions of the gender gap can be very different depending on the two statistical measures used, we need both to better understand the reality.
2. In the application to gender differences for four health indicators for 200 countries S-time-distance measure led to perception of greater gender disparities than the static measures. For selection of countries in the group with long persistent domination in time of either gender, those with S-time-distances as time lead or time lag of gender difference beyond duration of 20 years were selected. For life expectancy at birth and for obesity about 100 countries out of 200 analysed fall into this category. In both fields the prevailing dominance of women with values being higher than for men persevered for more than for two decades. For mean MBI the gender concentration is more balanced. Distinctly different, diabetes showed higher values for men than women, the countries being more than 20 years ahead of those for women were concentrated in high income countries.
3. What was astonishing were large differences between the four health indicators and large differences between countries in each group as measured with S-time-distances. The gender difference in these four indicators can be important from both the medical and social standpoint, and these results can be further elaborated in much more details with additional studies. On the one hand, the same data sources from the Institute of Health Metrics and Evaluation (IHME) at the University of Washington on many health conditions around the world can be additionally studied with S-time-distance methodology. On the other hand, for more elaborated studies of the multiple factors behind the astonishing magnitude of country differences in the gender gap across medical, social, and economic factors could benefit from these results and S-time-distance methodology.
4. With these three additional tools, two generic statistical measures and time matrix tabulation, it is possible to get from existing time series databases a new perspective related to time, i.e. new insights from existing data in units of time which is understood by everybody. An added complementary possibility to look at differences in the parallel universe of time, adding new vocabulary in the semantics of discussing and analysing differences in the real world, can be extended to very diverse fields of interest beyond the example of gender life expectancy here. The recommendation is that experts in numerous fields would examine how their substantive knowledge of the field can be combined with this dual parallel system suggested to help the discovery by, as Marcel Proust would say, 'seeing with new eyes'.

References:-

1. Eurostat (2018), Life expectancy by age and sex [demo_mlexpec] Last update: 10-09-2018. Accessed 28 November 2018.
2. Granger C.W.J., Jeon Y. (1997), Measuring Lag Structure in Forecasting Models – The Introduction of Time Distance, Discussion Paper 97–24, University of California, San Diego.
3. Granger C.W.J., Jeon Y. (2003a), A time-distance criterion for evaluating forecasting models, International Journal of Forecasting, Vol. 19.
4. Granger, C.W.J., Jeon, Y. (2003b). Comparing forecasts of inflation using time distance, International Journal of Forecasting, Vol. 19.
5. ITU (2010), Measuring the Information Society 2010, Geneva. 3.3 Time-distance analysis: 43-52.
6. Kulkarni et al. (2011), "Falling behind: life expectancy in US counties from 2000 to 2007 in an international context," Population Health Metrics 2011 9:16, doi:10.1186/1478-7954-9-16.
7. NCD Risk Factor Collaboration (NCD-RisC) (2016a), Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19•2 million participants, Lancet 2016; 387: 1377–96.
8. NCD Risk Factor Collaboration (NCD-RisC) (2016b), Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4•4 million participants, Lancet 2016; 387: 1513–30.
9. NCD Risk Factor Collaboration (NCD-RisC) (2016c), Data downloads, http:// -downloads.html. Accessed 22 April 2016.
10. Sicherl, P. (1973), "Time Distance as a Dynamic Measure of Disparities in Social and Economic Development," Kyklos XXVI(3): 559−575.
11. Sicherl, P. (1993), Integrating Comparisons Across Time and Space, Methodology and Applications to Disparities within Yugoslavia, Studies in Public Policy, No 213. Centre for the Study of Public Policy, University of Strathclyde, Glasgow.
12. Sicherl, P. (2004), Time distance: a missing link in comparative analysis, 28th General Conference of The International Association for Research in Income and Wealth, Cork, Ireland, August 22-28, 2004. http://www.iariw.org
13. Sicherl, P. (2005), Pilot study: Sectoral time-distances in the adoption of e-commerce activity, in The European e-Business Market Watch, European Commission, DG Enterprise & Industry, http://www.ebusiness-watch.org/
14. Sicherl, P. (2007), "The inter-temporal aspect of well-being and societal progress," SocialIndicators Research 84: 231−247.
15. Sicherl, P. (2011a), Time Distance in Economics and Statistics, New Insights from Existing Data, pp 444. Edition echoraum, Wien.
16. Sicherl, P. (2011b), New Understanding and Insights from Time-Series Data Based on Two Generic Measures: S-Time-Distance and S-Time-Step. OECD Statistics Working Papers. 2011/09. OECD Publishing. Paris. http://dx.doi.org/10.1787/5kg1zpzzl1tg-en.
17. Sicherl, P. (2013), A geek's guide to measuring the MDGs, Guardian Professional, The Guardian, Friday 1 March 2013 12.48 GMT, web page
18. Sicherl, P. (2014a), Inter-Temporal Aspect of Wellbeing. In A. C. Michalos (Ed.), Encyclopedia of Quality of Life and Well-Being Research. Dordrecht, Netherlands: Springer, p. 3353-3363.
19. Sicherl, P. (2014b), How Much Longer Live Women Than Men Around the Globe? Astonishing Differences between Countries, Printed by CreateSpace, Charleston SC.
20. Sicherl, P. (2014c). European Union at a Glance, Printed by CreateSpace, Charleston SC.
21. Sicherl, P. (2015), System for Monitoring Implementation of Targets: Present MDGs and Post-2015 SDGs, Printed by CreateSpace, Charleston SC. http://www.gaptimer.eu/report4.pdf
22. UN (2011), Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2010 Revision, CD-ROM Edition.
23. UN (2014), MDG Report 2014, Statistical Annex, New York.
24. UN (2015a), MDG Indicators. Accessed May 12, 2015. http://mdgs.un.org/unsd/mdg/Data.aspx.
25. UN (2015b), MDG Report 2015, Statistical Annex, New York.
26. UN (2015c), MDG Indicators. Accessed July 7, 2015. http://mdgs.un.org/unsd/mdg/Data.aspx
27. UN (2015d), Department of Economic and Social Affairs, Population Division World Population Prospects: The 2015 Revision, DVD Edition.
28. Wilber, K. (2014), What, you ask, is a human operating system? Accessed May 22, 2014. http://superhumanos.net/.