Session Number: PLENARY SESSION 5 CONTINUED
Session Title: Measuring and Interpreting Trends in Global Inequality and Poverty
Session Organizers: Stephan Klasen and D. S. Prasada Rao

Paper for the 28th General Conference of the International Association for Research in Income and Wealth Cork, Ireland, August 22-28, 2004

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Financial support of The Ministry of Education, Science and Sports, The Ministry of Information Society and of The Institute of Macroeconomic Analysis and Development is gratefully acknowledged.

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Abstract

The new generic time distance approach (with associated novel statistical measure S-distance) offers a new view of data that is exceptionally easy to understand and communicate, and it allows for developing and exploring new hypotheses and perspectives. This approach can help that the conceptual and the statistical framework for dealing with the problems of interrelationships between growth, efficiency, inequality, convergence and benchmarking can reach beyond the conventional predominately static approach providing a broader dynamic framework for research, policy analysis and debate.

1. INTRODUCTION

In research the art of handling different views of data is crucial for discovering and understanding the relevant patterns and for providing a broader framework for policy analysis. The paper discusses a new view of the information, using levels of the variable(s) as identifiers and time as the focus of comparison and numeraire, and deals with two issues.

First, in Section 2 it is outlined that in the information age this new view of the existing databases should be evaluated as an important contribution to a more efficient utilisation of the available information. 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.

Second, the role of the outlined time distance methodology is not restricted to its generic characteristics for statistics and econometrics. The time perspective, which no doubt exists in human perception when comparing different situations, is systematically introduced both as a concept and as a quantifiable measure in comparative analysis. This leads to a notion of the two-dimensional analysis of disparities: disparity (proximity) in the indicator space and disparity (proximity) in time. It will be shown that the degree of disparities may be very different when evaluated in static terms and in time. This is discussed in Section 3.

Section 4 presents empirical results on the time dimension of disparities for GDP per capita between world regions based on historical statistics by Maddison (2003). Furthermore, also the discussion of convergence and divergence should be based on both dimensions. Section 5 presents a theoretical scheme for classification of various cases and an empirical example showing that for three EU cohesion countries the conclusion about convergence or divergence for the period 1973-2001 is different if based on relative static measure or on time distance. Section 6 draws the conclusions.

2. COMPARING IN TWO DIMENSIONS: A BROADER CONCEPT AND A NOVEL STATISTICAL MEASURE OF THE TIME DIMENSION OF DISPARITIES

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. 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 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 (see e.g. Sicherl, 1969, 1973, 2004a and 2004b).

Time distance in general means the difference in time when two events occurred. We define a **special category of time distance**, which is related to the level of the analyzed variable. The suggested statistical measure **S-distance** measures the distance (proximity) in time between the points in time when the two series compared reach a specified level of the variable X. 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.

In the analysis of time series the idea of time distance is a generic concept like static difference and the growth rate over time. Time has been until now used in comparisons mainly as locational 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 approach offers new avenues for detecting additional information content, without replacing the existing views. If we choose to interchange in the database the roles of the level of the variable and time, a given level of the variable becomes a descriptor or identifier and time becomes a numeraire in which certain distances between the compared units and time series can be expressed and measured.

Comparing two points in a time series database entails three elements of information: (i) the respective level of the variable, (ii) to which unit it belongs, and (iii) at what time it happened. There are two obvious generic directions of comparison: by time and by level.

The generic nature of S-distance can be shown also by specifying operators that can be applied to a time series database. For two units (i) and (j) we can express such database as implicit functions[1]

$$F_i(X, t) = 0 \text{ and } F_j(X, t) = 0. \qquad (1)$$

The present state-of-the-art solves these functions by one of the arguments as

$$X = X_i(t) \text{ and } X = X_j(t) \qquad (2)$$

[1] See also Sicherl (2004c).

and arrives at static distance like $\Delta X_{ij}(t) = X_i(t) - X_j(t)$. However, it misses the point that additional theoretically universal and practically relevant measures can be obtained by solving them by the other argument using the inverse relations

$$t = t_i\,(X) \text{ and } t = t_j\,(X). \qquad (3)$$

The result is a time matrix with new information from which new generic measures can be derived.

Table 1. Time matrix from the inverse relations: 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}	$t_i\,(X_{Ln})$	

Two operators applied to the above time matrix lead to the derivation of two novel statistical measures expressed in standardized units of time that everybody understands. The first suggested statistical measure ***S-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 ***horizontally*** the respective times for a given level in the time matrix.
S-distance for a given level of X_L is defined as[2]

$$S_{ij}(X_L) = \Delta t(X_L) = t_i(X_L) - t_j(X_L) \qquad (4)$$

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)

$$S_{ij}(X_L) = -S_{ji}(X_L). \qquad (5)$$

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

Subtracting the respective times in the time matrix for consecutive levels of the variable for each column ***vertically*** derives the second suggested measure ***S-step***. These vertical differences can be labelled as time steps and represent an alternative description to the growth rate measure. The concept of S-step measures the growth

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

characteristics of a series, using the inverse relation to the conventional $\Delta X/\Delta t$ or growth rate metrics. S-step as a measure expressed in units of time is defined as

$$S_i(\Delta X_L) = (t_{XL+\Delta X} - t_{XL})/\Delta X. \qquad (6)$$

S-step is obtained by simple subtraction of consecutive times in columns in the time matrix in Table 1 if ΔX_L is kept constant. This second statistical measure S-step and its relation to S-distance will not be discussed further in this paper.

Since events are dated in time, in time series comparisons, regressions, models, forecasting and monitoring, the notion of time distance always existed as a "hidden" dimension. What was needed was to systemize and formalize the approach and define an appropriate statistical measure for operational use. In this paper we shall apply the S-distance methodology in a limited way mostly to the international comparisons of per capita GDP across world regions and to the discussion of convergence in two dimensions for selected countries. In this domain S-distance plays a role of a generic concept like static measures of disparity or growth rate.

However, this generic approach can be usefully applied as an important analytical and presentation tool to a wide variety of substantive fields at macro and micro levels. For extensions to measuring deviations between estimated and actual values in regressions and models, forecasting, error in timing and causality, monitoring, business cycle analysis see Sicherl (1994, 1997), to variables other than time Sicherl (1999a).

Granger and Jeon (1997, 2003a) extended it to comparisons of leading and lagging indicators and used the time distance as a criterion for evaluating forecasting models[3]. They also analyzed four models of inflation in the USA not only with the standard method of average squared deviations between the projected and actual values, but also with the time distance method deviations, which produced significantly different results (Granger and Jeon, 2003b).

Time distance approach brings about two persuasive advantages for extensive use. First, expressed in time units, time distance is comparable across variables, fields of concern, and units of comparison. Second, earlier results are left unchanged, but new conclusions may be reached due to an added dimension of analysis.

3. THE TWO-DIMENSIONAL NOTION OF THE OVERALL DEGREE OF DISPARITY - NEW INSIGHT FROM EXISTING DATA

The advantages of having a broader conceptual framework for a better understanding of the reality far outweighs the disadvantages in dealing with more than one possibility of combining static and temporal distances in a formally consistent

[3] ‘As Sicherl (1973, 1993) proposes, for a given level of the lagged or leading indicator, a time distance measures distance *in time* between the indicator and the indicated variable. 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’. ……’Sicherl's several works have presented a non-technical discussion of the theory of time-distance. This concept can help us to think more clearly about the forecastibility of series’ (Granger, Jeon, 1997).

analytical framework[4]. Consequently, we define the concept of the overall degree of disparity (proximity) that is based on a simultaneous perception of proximity in indicator space and proximity in time, as both of them matter level (see e.g. Sicherl 1992).

Figure 1 portrays the position that the overall degree of disparities should be measured in two dimensions; the existing static measures of disparity (proximity) in the indicator space should be complemented by proximity in time. In other words, the difference between the values for the two units could be measured both in vertical dimension (the most commonly used are absolute differences expressed in the units of the indicator or relative differences) as well as in horizontal dimension, i.e. in terms of time for a given level of the variable that leads to the notion of time distance. 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.

Figure 1 presents a simple, but not simplistic case of comparing two countries or regions or social groups for a given indicator, assuming two scenarios: scenario A assumes growth rate of 4%, and scenario B growth rate of 1%, for simplicity reasons both units are growing at the same rate of growth, respectively. In the two compared units, the value of the indicator for region 1 is 50% higher than that of region 2 in both scenarios. If one uses for the evaluation of the magnitude of the gap between the two regions the conventional statistical measures like ratio, percentage, Gini coefficient, Theil index, they show the same values for scenario A and scenario B over time. While the present state-of-the-art distinguishes the two situations by the different growth rates, it does not recognize that the difference in the growth rates had an effect on the degree of disparity, as these static measures of disparity show the same degree of disparity for the two scenarios.

Now let us take a broader view of the situation. The concept of time distance as one of the dimensions of disparity leads to a different conclusion about the degree of disparity in scenario A and in scenario B. In the 4% growth rate for scenario A with the 50% static disparity the time distance between the two regions is 10 years, in scenario B with 1% growth rate the time distance between the compared regions is 40 years. The two-dimensional notion of the overall degree of disparity leads to a different qualitative conclusions about the difference in the degree of disparity between the two scenarios. The present theory does not take this into account as it is built on a one-dimensional perspective of looking at the degree of disparity. However if people would be asked to compare two scenarios, one with 50% static disparity and 10 years of time distance, and the other with 50% static disparity and 40 years of time distance, it is highly unlikely that people would perceive such situations as equal degrees of disparity, as it is concluded by the above mentioned conventional static measures of disparity[5]. Conventional welfare theory would need to explain why it would not be possible to incorporate such broader way of thinking and the changed semantics into the present state-of-the-art.

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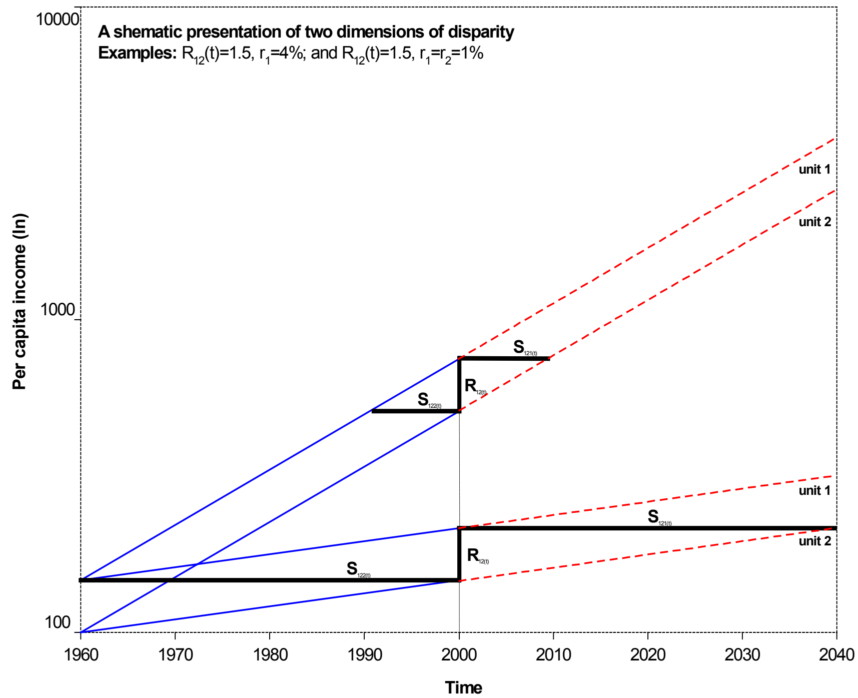
[4] This section is based on Sicherl (2004a), where also details on different methods for estimating S-distances and the relations between static measures and time distances are discussed.

[5] Testing such a hypothesis is not easy since we do not know what relative weight people assign to the static disparity and time distance in their perception of the overall degree of disparity. But in view of the positive time preference it is unlikely that a zero weight would be given to the time distance dimension.

The analytical conclusion that higher magnitudes of growth rates lead, ceteris paribus, to smaller time distances, and vice versa, is important in explaining past developments and in preparing policy recommendations. In the dynamic world of today it is hardly satisfactory to rely only on static measures of disparity which are insensitive to the magnitudes of the growth rates and take into account only differences in the growth rates between the units. In this respect time distance plays in the analysis of disparities an important role, quite distinct from that of static measures.

Figure 1. Concept of overall degree of disparity: simultaneously perceiving and measuring differences in two dimensions (in value and in time)



Static relative disparity and time distance:
higher (4%) growth example R=1.5, S=10 years;
lower (1%) growth example R=1.5, S=40 years.

For instance, for the analysis of convergence and the degree of cohesion in the EU[6] a very important policy conclusion arising from this framework is that the degree of disparity and thus cohesion will depend also on how fast, and not only how much faster than the average, will the less developed regions (countries) and the potential member countries grow in the future. In technical terms, the reduction of relative difference (expressed as a ratio of the values of the indicator for the two compared units) will depend only on the difference between the respective growth rates ($r_2 - r_1$), while the time distance will depend also on the absolute magnitude of the respective growth rates.

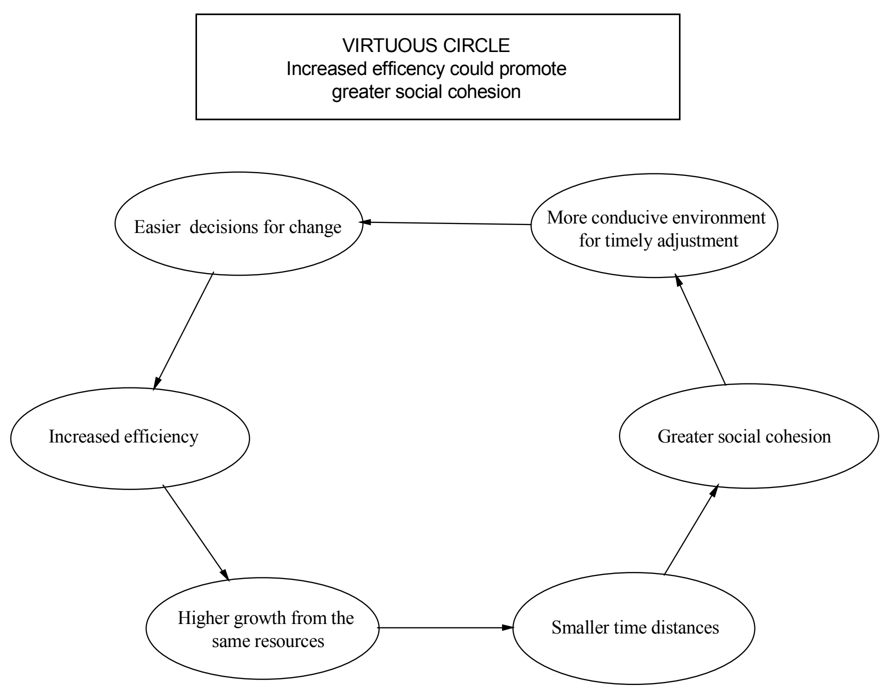
Thus the policy considerations aiming at reducing disparities and alleviating poverty must be concerned *also* with the absolute magnitudes of the growth rates of the indicator (r_2 and r_1), and *not only* with the difference in the growth rates ($r_2 - r_1$).

[6] For an empirical example see Section 5.

Higher magnitude of the growth rates brings a net reduction in time distance in addition to whatever reduction in time distance has been achieved by the improvement in the relative difference. Factors that influence the magnitude of overall and sector growth rates also influence the overall degree of disparity via time distance, if at the same time appropriate distributional policies are being followed in the general strategic orientation for growth and equity (Sicherl, 1992).

If people take into account also time distance as one element of their subjective evaluation of the (overall) degree of disparity, a new set of hypotheses with important economic, social and political consequences follows. An important hypothesis about the interrelationship between efficiency, growth and disparity can be formulated. In the conventional theory the trade-off between growth and inequality is emphasized. In this framework a high growth rate (with appropriate distribution policy) is not only a means for reaching higher levels of satisfaction of needs faster, but can be also a means of reducing disparities, at least in the time dimension. Increased efficiency leads to higher growth from the same resources, this leads to smaller time distances that in turn could mean greater social cohesion, enabling a more conducive environment for timely adjustment to changes supporting increased efficiency and effectiveness, and the 'virtuous' circle can continue.

Figure 2.



Higher growth can thus produce both positive and negative effects on social cohesion. The 'vicious' circle would work in the other direction; inefficiency has important negative economic and political consequences as far as disparities are concerned (Sicherl, 1992). Lower growth rates should signal to politicians that an increase in the degree of disparity may be felt and that social tension may be increasing and cohesion decreasing.

In the above theoretical discussion, the new insights brought about by the introduction of time distance were applied to the cases where the rates of growth of a given indicator have been changing over time. Furthermore, the impact of the magnitude of the growth rates can also be studied across different indicators and again there are ample examples of the statement that static measures of disparity and time distance measure can lead to very different analytical and policy conclusions[7]. Obviously, for a proper evaluation both dimensions should be analyzed simultaneously.

4. THE TIME DIMENSION OF DISPARITIES IN THE WORLD (Disparities in GDP per capita between major regions of the world)

International comparisons are subject to problems of accuracy, coverage and comparability of data, and the conclusions should be approached with the necessary caution. Our purpose is to indicate an order of magnitude of the time dimension of the inequality in the world with respect to this indicator[8]. We appreciate the possibility to use long time series of GDP per capita in comparable prices from the most recent study on historical statistics by Angus Maddison (2003), which should be consulted for original data on GDP per capita and on assumptions used at arriving to the estimates. Maddison breaks the analysed countries into seven regions (the region 'Western Offshoots' is composed of USA, Canada, Australia and New Zealand).

Time distance (S-distance) values for these regions from the average value of GDP per capita for the world as a whole are presented in Table 2. To obtain as many crossings as possible in calculating time distances, different rules are used for world regions above and those below the world average. For above-the-average regions the base level of GDP per capita, for which the S-distance in Table 2 is calculated, is the average world level for the respective year and the time distances in the table have a negative sign indicating time lead for these regions. For below-the-average regions the base level for calculating time distance is their own level of GDP per capita in a given year, time distances have a positive sign indicating how many years these regions are lagging behind the average (e.g. the level of GDP per capita for Asia in 2001 was achieved in the world as a whole in 1971, indicating a time distance of 30 years).

Needless to say, the past time distances cannot serve as projections of future time dimension of disparity, which will depend on future performance. There is an important distinction between backward looking (*ex post*) and forward-looking (*ex ante*) S-distances. They relate to different periods, past and future, the first belongs to the domain of statistical measures based on known facts, the second is important for describing the time distance outcomes of the results of alternative policy scenarios for the future.

[7] Sicherl (1999c) analysed a selected set of economic and social indicators for five candidate countries and three EU cohesion countries in relation to the EU15 average. The rankings of degree of disparity across indicators were very different for relative static measure (EU15=100) and for time distances.
[8] For some earlier studies using time distance in this context see Sicherl 1999b and Sicherl 1998.

Thus one should be careful to use appropriate semantics with the new notion of the two-dimensional degree of disparity. S-distance of 30 years does not at all mean that e.g. Asia will need 30 years to reach the world average income. The value of this special category of time distance is simply a statistical fact that the 2001 value for Asia was attained for the world average 30 years earlier, i.e. in 1971. What will be the time needed for Asia to reach the world average income will depend on the future growth rates[9] as explained in Section 3.

In view of the general problem of comparability of data, one should not assign much importance to small differences in inequality measures. It is interesting to observe that in 2001 the time lead of 'Western Offshoots' against the world average was about 80 years, while the time lag of Africa behind the world average was about 90 years. The regions with the highest and the lowest values are in terms of time distance about equally separated from the world average in different directions. This was even truer in earlier decades, in the last quarter of the century the time lag for Africa has been increasing.

The greatest improvement after World War II was achieved in Asia, which was in 1950 lagging the world average even more than Africa. By 2001 the time lag was reduced to 30 years. Eastern Europe dropped at the beginning of transition in 1990 from a position above the world average to that below the average and is by this data set positioned approximately equal with Latin America, at a level very similar to the world average. The former Soviet Union has from a time lead of about 25 years against the world average in 1993 started a great decline, so that in 2001 it lags behind the world average by 17 years. Western Europe, on the other hand, shows a lead of about 45 years against the world average.

There are several methodological issues related to the calculation and interpretation of the time distances. First, the inverse relations defined in (3) in the methodological section imply that the definition of S-distance in (4) can have multiple values as one or both compared units might have reached the given level of the variable several times. In special cases $t_i(X_L)$ and $t_j(X_L)$ in (4) can be a function of the level of the indicator X_L, while in general each of them might take more values when the same level is attained at more points in time, i.e. it is a vector which can in addition to the level X_L be related to time. Three subscripts are needed 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 the general case also the fourth subscript would be necessary to indicate to which point in time it is related ($T_1, T_2, ..., T_n$). For two compared series there could be several intersections, $T_i(X_L)$ with $\underline{m}$ values and $T_j(X_L)$ with $\underline{n}$ values. The corresponding matrix of time distances will have $\underline{m}$ times $\underline{n}$ elements. For continuously increasing or decreasing series there will be only one time distance value.

Second, in practical terms this means that in times of several business cycles, wars and transition depressions there are cases when the absolute levels of GDP per capita decline over time. Thus a selected level of the indicator is attained several times in the downward and upward fluctuations of the time series that complicates the presentation

[9] For the respective formulae see Sicherl (2004a), p. 11.

Table 2. Time distance (S-distance) for GDP per capita from the world average in years (- time lead, + time lag)								
Time	**Western Europe**	**Western Offshoots**	**Eastern Europe**	**Former Soviet U.**	**Latin America**	**Asia**	**Africa**	***WORLD AVG***
1900	-76	-78	-11	2	12			0
1913	-72	-80	-9	2	2	86		0
1950	-75	-93	0	-11	-14	119	79	0
1951	-73	-90	0	-10	-12	112	78	0
1952	-72	-89	1	-10	-11	101	78	0
1953	-71	-87	1	-10	-9	93	78	0
1954	-71	-86	0	-11	-9	90	77	0
1955	-69	-84	0	-10	-6	86	77	0
1956	-67	-84	0	-10	-6	83	76	0
1957	-67	-84	-1	-11	-6	83	76	0
1958	-67	-84	-1	-11	-5	81	77	0
1959	-66	-84	-2	-11	-5	80	76	0
1960	-64	-83	-2	-11	-5	78	75	0
1961	-63	-83	-3	-11	-5	79	76	0
1962	-61	-83	-3	-10	-5	78	76	0
1963	-61	-82	-4	-10	-6	76	73	0
1964	-58	-81	-4	-10	-4	71	72	0
1965	-57	-80	-3	-10	-3	70	70	0
1966	-56	-79	-3	-11	-2	66	71	0
1967	-55	-79	-4	-12	-3	66	72	0
1968	-54	-77	-4	-12	-2	64	71	0
1969	-52	-76	-4	-12	-2	60	68	0
1970	-50	-75	-5	-12	-2	57	65	0
1971	-49	-75	-5	-11	-2	55	65	0
1972	-48	-74	-6	-12	-2	52	65	0
1973	-44	-72	-5	-12	-2	48	66	0
1974	-45	-73	-6	-13	-3	49	65	0
1975	-46	-74	-7	-14	-4	47	67	-2
1976	-42	-74	-7	-12	-4	44	66	0
1977	-39	-74	-7	-13	-5	41	66	0
1978	-35	-74	-8	-14	-5	37	67	0
1979	-32	-74	-8	-15	-6	36	67	0
1980	-33	-75	-9	-16	-7	35	66	0
1981	-33	-76	-10	-17	-8	33	69	0
1982	-35	-77	-11	-18	-9	32	70	-3
1983	-34	-77	-12	-18	-10	32	72	0
1984	-34	-77	-13	-19	-9	32	74	0
1985	-34	-77	-13	-19	-9	31	75	0
1986	-35	-77	-14	-20	-10	32	76	0
1987	-35	-77	-14	-20	-10	31	78	0
1988	-36	-77	-15	-21	-10	30	78	0
1989	-36	-77	-15	-21	0	30	79	0
1990	-37	-78	-16	-22	2	30	81	0
1991	-38	-79	5	-23	-13	30	84	-2
1992	-39	-80	9	-24	-13	29	86	-2
1993	-40	-81	12	6	-14	29	88	0
1994	-41	-80	10	18	-15	29	90	0
1995	-41	-80	8	23	-15	29	90	0
1996	-42	-80	3	25	0	28	89	0
1997	-42	-79	3	25	0	28	89	0
1998	-43	-80	2	27	-1	29	89	0
1999	-44	-79	2	26	1	30	90	0
2000	-44	-78	1	23	1	29	90	0
2001	-45	-79	1	17	2	30	90	0

Source: own calculations based on the historical GDP per capita estimates from Maddison (2003).

of the alternative time distance calculations. There are several options to select from, like first, last, average or intersection, etc. The choice among them depends on the decision of the user, i.e. which of them is most appropriate for analysis of the case under scrutiny. Results presented in Table 2 follow two decisions. Yearly values of GDP per capita were used from 1950 on, for the earlier period interpolations between the values for years 1820, 1870, 1900, 1913, 1929 and 1950 from Maddison (2003) were used. In this way the fluctuations in the two world wars and major earlier depressions were to a great extent eliminated. However, the effects of the fluctuations in Latin America in the last twenty years and the radical decline in Eastern Europe and especially in the former Soviet Union in the transition depressions are included. It is of interest to observe that there are very few cases of absolute decline in GDP per capita for the world average (see four non-zero values in the last column of Table 2). It seems that the fluctuations in different world regions are not synchronised to the degree that they would produce a uniform pattern for the world as a whole.

Third, as mentioned before, for above-the-average regions the base level of GDP per capita, for which the S-distance here is calculated, is the average world level for the respective year, while for below-the-average regions the base level is their own level of GDP per capita in a given year. Taking into account these choices for alternative variants of calculating time distances the estimates presented in Table 2 present a novel descriptive picture of a dimension of the degree of inequality for GDP per capita among the world regions. This information complements, rather than substitutes, the conventional measures of static absolute or relative statistical measures of inequality and the associated growth rates. Due to the lack of space we shall not elaborate on the combination of various statistical measures in describing and assessing the trends in the degree of global inequality. What has been established with this example is the fact that from existing datasets (like Maddison, 2003) a time series of a novel statistical measure with evident interpretability can be developed.

In addition to the information provided by most commonly used static relative measures and growth rates, the information on S-distance provides an additional dimension of the assessment of the situation that is easily comprehended even by politicians and the general public. For instance, the world average level of GDP per capita in 2001 was according to data from Maddison (2003) attained in 'Western Offhoots' already in 1922, and in Western Europe in 1956. On the other side, Eastern Europe and Latin America are about at the average level of the world; the present level of the former Soviet Union was attained by the world average in 1984, of Asia in 1971 and of Africa already in 1911.

Values of S-distances in Table 2 are *ex post* time distances. While the trend in static relative measures like ratio or index depends only on the differences in the growth rates between the compared units, trends in S-distance depend in addition to that also on the absolute levels of the respective growth rates. In the period of high growth rates (1950-1973) there was a considerable decline in the dimension of inequality measured by S-distance for several regions. The time lead of 'Western Offshoots' declined from 93 years to 72 years, for Western Europe from 75 years to 44 years. The time lag for Asia declined from 119 years to 48 years and that of Africa from 79 years to 66 years. These were very considerable trends related to the two most advanced and the two least developed world regions. These trends are describing one dimension of global inequality in that period, notwithstanding the fact, that absolute differences in the level of GDP per capita among them were increasing and that the changes in ratios or indices have been much less pronounced or even moved in the opposite direction. This is another indication that the time distance approach usefully complements existing measures and perceptions.

In the period 1973-2001 there were fluctuation but not substantial changes in time distances for the two most developed world regions with respect to the world average. Contrary to that, in the three regions closer to the world average there were drastic breaks in the trend for the former Soviet Union and for Eastern Europe, and considerable fluctuation in Latin America. The two least developed regions show diametrically opposite developments. The time lag for Africa increased from 66 years in 1973 to 90 years in 2001, while that of Asia decreased from 48 to 30 years. Absolute differences between the more developed and less developed regions continued to increase, only for Asia in this subperiod the absolute difference to the world average was about constant. This region has also the greatest population weight, so that any possible improvements in summary measures of the degree of inequality in the world is to come from the improvements in the value of GDP per capita for this region.

5. CONVERGENCE VIEWED IN TWO DIMENSIONS: PROXIMITY IN TIME AND PROXIMITY IN THE INDICATOR SPACE

Convergence usually implies a decrease in terms of relative static measures (ratio or percentage) over time. The decrease in the ratio of the values of the indicator between two compared units depends only on the difference between their growth rates for this indicator, while the time distance depends both on the difference between their growth rates and on the absolute value of the growth rates of the indicator (Sicherl, 1978). Therefore, convergence (divergence) should be discussed in two dimensions: closer (farther) in ratio and closer (farther) in time. In the present usage of the term convergence there is only a simple classification of cases into 'yes' and 'no', where the latter case would include also the case of unchanged relationship.

Table 3. Convergence viewed in two dimensions: proximity in time and in space (3 x 3 classification of cases)

	Distance in indicator space		
Distance in time	*1* Ratio ↑ S-distance ↑	*4* Ratio = S-distance ↑	*7* Ratio ↓ S-distance ↑
	2 Ratio ↑ S-distance =	*5* Ratio = S-distance =	*8* Ratio ↓ S-distance =
	3 Ratio ↑ S-distance ↓	*6* Ratio = S-distance ↓	*9* Ratio ↓ S-distance ↓

Table 3 shows now 9 different combinations of a static measure of disparity and time distance. In this table ratio of the levels of the analysed indicator is used as a possible choice of static measures of disparity. However, other static measures of disparity could be also used in this classification in line with the preference of the researcher or policy maker. In the Table 3 one can find on the diagonal the three cases where the static measure and the time distance lead to the same qualitative conclusion, i.e. a unanimous conclusion of convergence in the sense that the direction of proximity is the same both in space and in time. In all other six cases even the conclusion about the direction of change in the two measures is not the same. In such cases it is not easy to evaluate what has happened with the overall degree of disparity, one would need to know people's preferences with respect to the weights given to the static and temporal dimension of disparity.

Table 4. Time distance (S-distance) for GDP per capita from the Western Europe average in years (- time lead, + time lag)

Time	*WE12*	*IRL*	*GRE*	*PRT*	*ESP*	*USA*
1965	0	15	32		24	-18
1966	0	16	25		16	-17
1967	0	15	19	35	16	-17
1968	0	15	17	23	15	-17
1969	0	15	16	20	15	-16
1970	0	15	15	18	15	-11
1971	0	16	15	17	15	-12
1972	0	15	12	17	13	-11
1973	0	15	13	14	13	-10
1974	0	15	15	15	12	-11
1975	-2	16	15	19	12	-12
1976	0	17	14	19	13	-12
1977	0	16	15	18	13	-13
1978	0	16	14	19	13	-13
1979	0	16	15	19	14	-13
1980	0	17	16	19	15	-14
1981	-1	17	17	19	16	-15
1982	0	18	18	20	16	-16
1983	0	19	19	21	17	-16
1984	0	19	19	22	17	-16
1985	0	19	19	23	18	-16
1986	0	21	20	23	18	-15
1987	0	20	21	22	18	-15
1988	0	20	21	21	18	-15
1989	0	19	21	20	17	-13
1990	0	18	22	20	17	-14
1991	0	18	23	20	17	-15
1992	0	18	24	21	17	-16
1993	-2	17	25	22	20	-17
1994	0	17	26	23	19	-17
1995	0	12	27	23	19	-18
1996	0	10	27	23	19	-18
1997	0	6	27	21	19	-19
1998	0	1	27	21	16	-17
1999	0	0	27	21	15	-16
2000	0	-1	27	20	15	-16
2001	0	-2	25	19	14	-17

Here we shall use an empirical example of developments in Western Europe broken down into the period of fast growth before 1973 and the period of slower growth after that, based again on data on GDP per capita from Maddison (2003). We shall look at the degree of disparity in the two dimensions for the four so-called EU cohesion countries. As a proxy for the EU average we shall use the aggregate Western Europe 12 (WE12) available in the above source. Table 4 shows the estimated values of time distances for these countries from the WE12 average for a greater portion of the post WWII development.

These values are estimated on similar assumptions as those in Table 2 for the world regions. They are based on first interceptions for data on 1913, 1929 and then yearly values from 1950 on. In such a way one might try to avoid the effect of fluctuation due to the two world wars and the Great Depression. Obviously the estimated values would change if these fluctuations would be taken into account and if in such a case last interceptions would be selected. The high values of time distances in Table 4 for some countries in the 1960's are a result of the sluggish average growth in Europe in the period 1913-1950. The time distances for the cohesion countries decline substantially with the high post-war growth.

Comparison between WE12 and the USA is a good example of the effect of the growth rates on the values of S-distance. In 1961 the value of GDP per capita was in the USA higher than in WE12 for 44 per cent, and the ex post S-distance was about 20 years. By 1973 the percentage difference was 37 per cent and time distance 10 years. In 2001 the percentage difference amounted to 40 per cent, with time distance of 17 years. Obviously, as far as the direction of change is concerned, in the period 1961-1973 disparity declined in both dimensions and in the period 1973-2001 it increased in both dimensions. However, the magnitude of change in the two dimensions of disparity is different in the periods with different growth rates. In the first period of fast growth, the improvement in the comparative position of WE12 was seven percentage points in static terms and 10 years in terms of time distance (from 20 years to 10 years). The deterioration in the period 1973-2001 of only 3 percentage points in static terms increased the respective time distance from 10 years in 1973 to 17 years in 2001, i.e. for 7 years. The main factor in these changes in time distance was not the corresponding change in the static relative position, but the effect of the faster and slower overall growth rates in the compared period (as explained in Section 3).

Similar effect for cohesion countries is shown in Tables 6 and 7. In the period of overall high growth rate 1966-1973 both the static percentage differences as well as the time distances with the WE12 average declined, only the position of Ireland stayed approximately unchanged. One can talk of convergence in both dimensions. The period 1973-2001 is a different story. First, in the late 1980’s Ireland started its very successful period of high growth and has later surpassed the WE12 average. In 1988 it was still on par with the other cohesion countries, then it has in about ten years eliminated the twenty years of time lag behind the average. This is a suitable example that ex post S-distances should not be understood as an estimate of the time needed to catch up with the benchmark.

Figure 3.

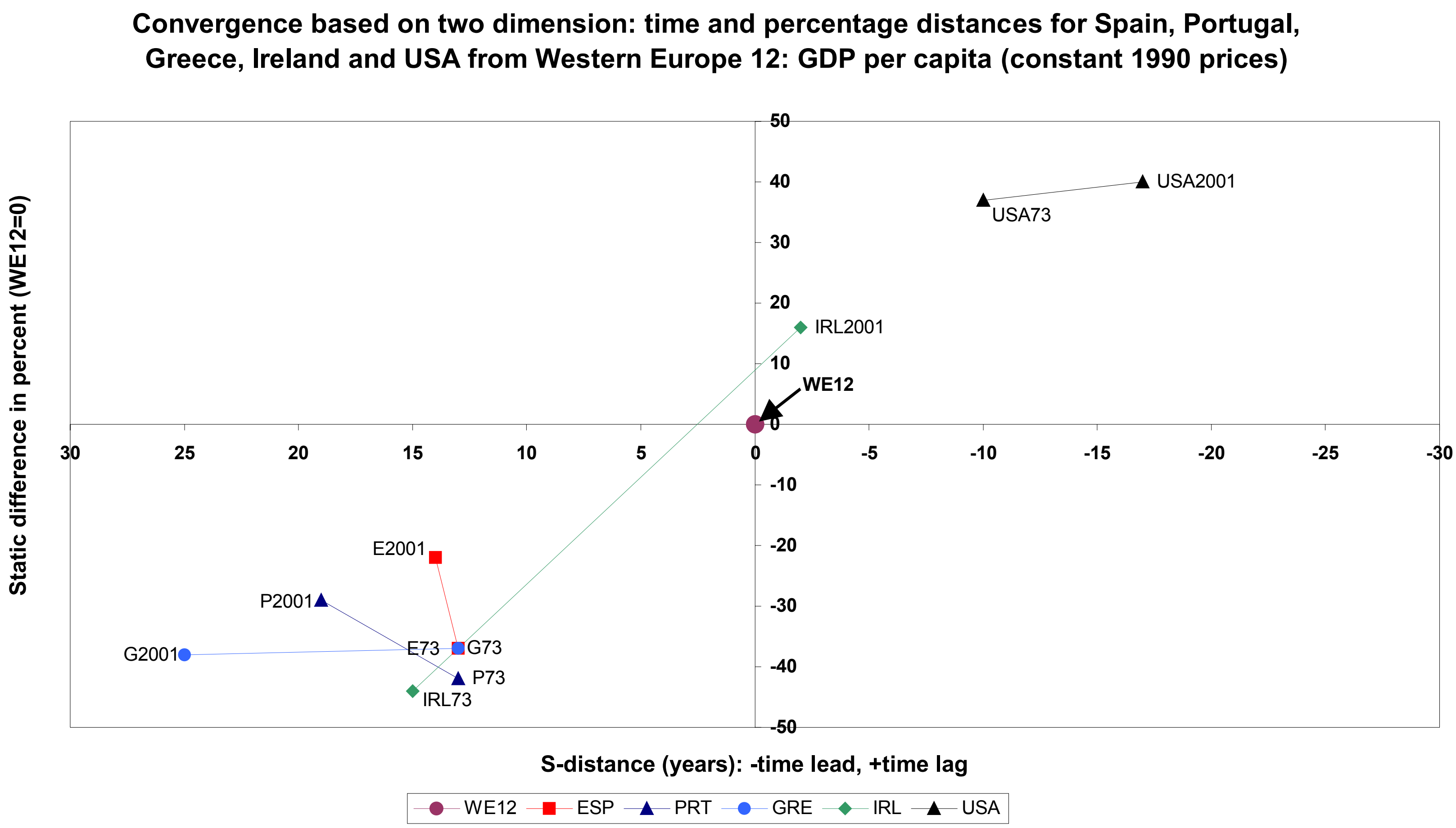

Convergence based on two dimension: time and percentage distances for Spain, Portugal, Greece, Ireland and USA from Western Europe 12: GDP per capita (constant 1990 prices)
Static difference in percent (WE12=0)
S-distance (years): -time lead, +time lag
50
40
30
20
10
0
-10
-20
-30
-40
-50
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
USA2001
USA73
IRL2001
WE12
E2001
P2001
E73
G73
G2001
P73
IRL73
WE12
ESP
PRT
GRE
IRL
USA

Table 5. GDP per capita, time distance (S-distance) in years (- time lead, + time lag) and percentage difference from the Western Europe average (WE12)

	Time distance from WE12				Percentage difference from WE12			
	Ireland	Spain	Portugal	Greece	Ireland	Spain	Portugal	Greece
1966	15	16	23	25	-44	-46	-52	-50
1973	15	13	13	13	-44	-37	-42	-37
2001	-2	14	19	25	16	-22	-29	-38

For Ireland 1964 instead 1966, for Portugal 1968 instead of 1966.

Table 6. Conclusions about convergence based on two dimensions: static relative disparity and time distance (empirical example for Table 3)

	Distance in indicator space		
Distance in time	*1*	*4* GRE 1973-2001	*7* PRT 1973-2001
	2	*5* IRL 1964-73	*8* ESP 1973-2001
	3	*6*	*9* ESP,PRT.GRE 1966-73 IRL 1973-2001

The story for the other three cohesion countries is different, here the conclusions about the degree of disparity in the two dimensions are not the same. Following the theoretical scheme in Table 3 the results for the period 1973-2001 are shown in Table 6. Greece experienced practically no change in its relative position to the WE12, but time distance increased from 13 to 25 years. This is the case 4 in the theoretical scheme. Portugal improved its static relative position, but the time distance still increased from 13 to 19 years, which is case 7 in the scheme. Spain also improved its relative position, but the time distance stayed approximately constant, case 8 in the scheme. Thus for these three countries the conclusion about convergence or divergence for the period 1973-2001 is different if based on relative static measures or on time distances. Obviously, for a proper evaluation both dimensions should be analysed simultaneously.

6. CONCLUSIONS

The time distance concept and the novel statistical measure S-distance represent an additional view, relevant to many problems and applications in economics, management, research and statistics, asking new questions, formulating new hypotheses, establishing new semantics and reaching new conclusions. The broader concept of disparities and the S-distance methodology in Section 2 show that in the analysis of time series the idea of time distance is a generic concept like static difference and the growth rate over time.

Expressed in time units, time distance is comparable across variables, fields of concern, and units of comparison, and as such easily understood by professionals, policy makers, managers, media and the general public, influencing how experts and the general public form their perception about a given situation, and thus public opinion. Combined with other methods, earlier results are left unchanged, but new conclusions may be reached due to an added dimension of analysis.

First, the novel measure will in general give us an additional dimension of looking at any comparative situation. Thus one can expect the benefit of an additional descriptive and presentation concept/measure offering a fresh perspective on the situation under scrutiny in all time series applications. Even if the descriptive applications would be the only benefit of its use, it would be unwise not to take advantage of a new analytical tool. Section 4 shows the application of S-distance as a descriptive statistical measure in the assessment of the degree of disparity among world regions for GDP per capita. For instance, it is interesting to observe that in 2001 the time lead of 'Western Offshoots' against the world average was about 80 years, while the time lag of Africa behind the world average was about 90 years. The regions with the highest and the lowest values are in terms of time distance about equally separated from the world average in different directions.

Second, it will be shown in specific examples presented that the broader conceptual and analytical framework can lead to different conclusions than the conventional static analysis not only in quantitative but also in qualitative terms. The importance of the two-dimensional notion of the overall degree of disparity with important economic and political consequences is presented in Section 3. A very important qualitative conclusion was that with respect to convergence or divergence. There is the need for more flexible and varied semantics in discussing convergence and divergence in two dimensions: closer (or more apart) in static measures(s) and closer (or more apart) in time. The analytical conclusion that higher magnitudes of growth rates lead, ceteris paribus, to smaller time distances, and vice versa, is important in explaining past developments and in preparing policy recommendations.

In a dynamic world it is hardly satisfactory to rely only on static measures of disparity which are insensitive to the magnitudes of the growth rates and take into account only differences in the growth rates between the units. In this respect time distance plays in the analysis of disparities an important role, quite distinct from that of static measures. Section 5 presents a theoretical scheme for discussion of convergence and divergence in two dimensions. In the empirical part it is shown that for three EU cohesion countries (Spain, Portugal and Greece) the conclusion about convergence or divergence for the period 1973-2001 is different if based on relative static measures or on time distances.

Similar studies on the two-dimensional analysis of disparities can be done for other levels, like regional analysis and economic and social groups with respect to income, as well as for indicators in many other field of concern. It is hoped that professionals, who for comparative analysis use mainly customary static measures of disparity like coefficient of variation, standard deviation, or Gini coefficient, would be interested in application of the broader dynamic conceptual and analytical framework suggested in this paper. This is not a question of a greater precision in empirical analysis; it is first and foremost a question of the more complex perception of disparities and the policy consequences, which arise from using a broader dynamic analytical framework.

REFERENCES

Granger, C.W.J., Jeon, Y. 1997. Measuring lag structure in forecasting models – the introduction of time distance. UCSD economics discussion paper 97-24, (available at http://www.econ.ucsd.edu/papers).

Granger, C.W.J., Jeon, Y. 2003a. A time-distance criterion for evaluating forecasting models. International Journal of Forecasting 19, 199-215.

Granger, C.W.J., Jeon, Y. 2003b. Comparing Forecasts of Inflation Using Time Distance, International Journal of Forecasting, 19 (2003), 339-349

Maddison, A. 2003. The World Economy: Historical Statistics. OECD Development Centre. Paris

Sicherl, P. 1969. Analiza nekih elemenata za ocenu stepena razvijenosti republika i pokrajina. Ekonomska analiza 3, 5-28.

Sicherl, P. 1973. Time Distance as a Dynamic Measure of Disparities in Social and Economic Development. Kyklos XXVI, Fasc. 3, 559-575.

Sicherl, P. 1978. S-distance as a Measure of Time Dimension of Disparities, v Mlinar, Z., Teune, H. (ed.), The Social Ecology of Change, Sage Publications, London in Beverly Hills.

Sicherl, P. 1992. 'Integrating Comparisons Across Time and Space: Methodology and Applications to Disparities within Yugoslavia', Journal of Public Policy 12, 4.

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.

Sicherl, P. 1994. Time Distance as an Additional Measure of Discrepancy between Actual and Estimated Values in Time Series Models. International Symposium on Economic Modelling. The World Bank, Washington D.C.

Sicherl, P. 1997. Time Distance Measure in Economic Modelling; New Insight from Existing Data. Paper presented at the International Symposium on Economic Modelling organised by the European Economics and Financial Centre, London, July 23-25.

Sicherl, P. 1998. Performance of Transition Economies in Historical Perspective, Economies in Transition, Regional Overview, 2nd Quarter, Economist Intelligence Unit, London.

Sicherl, P. 1999a. A New View in Comparative Analysis. IB Revija XXXIII, 22-34.

Sicherl, P. 1999b, The Time Dimension of Disparities in the World, XII World Congress of the International Economic Association, August 23–27, Buenos Aires.

Sicherl, P. 1999c. Distance in Time between Transition Economies and the European Union, Empirical Economics, Vol.24, No.1.

Sicherl, P. 2002. Time Distance: A Missing Link in Comparative Analysis. The XV. World Congress of Sociology. July 9, Brisbane.

Sicherl, P. 2004a. Time Distance – A Missing Perspective in Comparative Analysis, eWISDOM, 2a/2004.

Sicherl, P. 2004b. Comparing in Two Dimensions: A Broader Concept and a Novel Statistical Measure of the Time Dimension of Disparities, European Societies, Volume 6, Number 2, 2004.

Sicherl, P. 2004c. Foresight and the Use of Time Distance Methodology a New Perspective Related to Time, EU-US Scientific Seminar, New Technology Foresight, Forecasting & Assessment Methods, 13-14 May 2004, Seville, Spain.