S-TIME-DISTANCE AS A NEW GENERIC STATISTICAL MEASURE FOR ANALYSIS AND VISUALIZATION OF TIME SERIES DATA

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Abstract

The novel generic statistical measure S-time-distance yields a radical new view of time series datasets that has been left unexplored by the present state-of-the-art. It represents an additional view, complementing rather than replacing the existing statistical measures of time series analysis. It is theoretically universal, intuitively understandable, and relevant to many problems and applications. Thus it can be usefully applied as an important analytical and presentation tool at macro and micro levels to a wide variety of substantive fields.

Section 2 provides the elaboration of S-time-distance as a novel generic statistical measure using levels of the variable(s) as identifiers and time as the focus of comparison and numeraire. Section 3 presents some practical examples of benchmarking in the EU and with the USA as well as offering an overview of possible applications for comparing actual values with estimated values, forecast, budget, plans, targets, etc. and for evaluating goodness-of-fit in regressions, models, forecasting and monitoring. The focus of empirical application is on monitoring implementation of Lisbon strategy in the time dimension in Section 4. Besides the evaluation of its implementation in the past the paper outlines the template for evaluating implementation of the re-launched Lisbon strategy at the national, EU and sub-national levels in two dimensions: static percentage deviation and S-time-distance.

Keywords: time distance, S-time-distance, S-time-step, time matrix, time series comparisons, benchmarking, monitoring, Lisbon strategy

JEL classification: C10, O11, O20, 052

1. INTRODUCTION

In empirical research and in decision-making, the art of handling and understanding different views of data is crucial for discovering of relevant patterns. The present state-of-the-art does not realize 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, 1973, 2002).

As events are dated in time, the notion of time distance is a rather natural perspective in time series analysis such as comparisons, regressions, models, forecasting and monitoring. As such it can be used to analyse a variety of problems. It is remarkable that the notion of time

distance was not developed earlier theoretically and as a standard statistical measure. In the information age this new view of the existing time series databases should be evaluated as an important contribution to a more efficient utilisation of the available information.

- The new generic time distance approach offers a new view of data that is exceptionally easy to understand and communicate, and it allows for developing and exploring new hypotheses and perspectives.
- It can also make important contribution to better exploitation of information resources in new ways and to the visualization of findings; it is also well placed to be used jointly with other methods.
- Expressed in time units it is an excellent presentation tool easily understood by policy makers, managers, media and general public, it can support decision-making as well as influence public opinion.

2. S-TIME-DISTANCE AS A NOVEL GENERIC STATISTICAL MEASURE

Using levels of the variable as identifiers and time as the focus of comparison and numeraire

Besides money, time is one of the most important reference frameworks in modern societies. Time distance in general means the difference in time when two events occurred. What is here systematically discussed both as a concept and as a quantifiable measure for various time series comparisons is a special category of time distance, which is related to the level of the analyzed variable. As explained, the theoretical underpinning of S-time-distance as a novel generic statistical measure is the idea that time series analyses can be effectively performed also in the horizontal dimension. This idea led to the introduction of the time distance concept as a measure of disparities in economic and social development (Sicherl 1969, 1973), which has evolved to a much more general approach over the years.

Under the perspective dominating in the literature, comparisons and evaluation of differences (disparities, gaps, deviations) between time series are made on the basis of absolute or relative values of a given variable (e.g. a socio-economic indicator) for given points in time. The prevailing emphasis lies thus in the differences between two time series data at each point in time, respectively.

The new perspective on time series, which for obvious reasons can be characterized as ‘temporal’, has its main focus on the horizontal differences in time for each level of analyzed indicator/variable for the two or more compared units. Under the new focus, time distance concept measures the differences in time for specified levels of the variable (indicator).

A new dimension is added while no earlier results are lost or replaced. This innovation opens the possibility for simultaneous **two-dimensional comparisons of time series data in two specified dimensions: vertically (standard measures of static difference) as well as horizontally (Sicherl time distance), providing a new dimension of analysis to a variety of problems.**

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 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 organize (or index) a set of variables. In other words, it has played the role of a descriptor, subscript or identifier. This 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.

Table 1. Comparison between two units for static difference and time distance

	TIME	**LEVEL**	**UNIT**	**Concept**	**Metrics**
TIME	same	2	2	static distance	Absolute or percentage difference, ratio, etc.
LEVEL	2	same	2	time distance	S-time-distance

The generic nature of S-time-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

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

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

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

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

$$t = t_i(X) \text{ and } t = t_j(X) \quad (3)$$

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

Table 2. 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-time-distance** measures the distance (proximity) in time between the points in time when the two compared series reach a specified level of the variable X. It compares two series by subtracting **horizontally** the respective times for a given level in the time matrix.

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

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

where

$$X_i(t_i(X_L)) = X_L \text{ and } X_j(t_j(X_L)) = X_L \quad (5)$$ [1]

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

$$S_{ij}(X_L) = -S_{ji}(X_L) \quad (6)$$

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

Subtracting the respective times in the time matrix for consecutive levels of the variable for each column **vertically** derives the second suggested measure **S-time-step**. The time elapsed between two levels represents an alternative description to the growth rate measure. The concept of S-time-step measures the growth characteristics of a series, using the inverse relation to the conventional $\Delta X/\Delta t$ or growth rate metrics. S-time-step as a measure expressed in units of time is defined as

$$S_i(\Delta X_L) = (t_{XL+\Delta X} - t_{XL})/\Delta X \quad (7)$$

S-time-step is obtained by simple subtraction of consecutive times in columns in the time matrix in Table 2 if ΔX_L is kept constant.

Using linear approximation, the relationship between S-time-distance and S-time-step for a selected ΔX_L is

$$S_{ij}(X_{L2}) = S_{ij}(X_{L1}) + S_i(X_{L2}-X_{L1}) - S_j(X_{L2}-X_{L1}) \quad (8)$$

Substantive benefits of some practical applications to economic, social and information society indicators are discussed at www.sicenter.si and www.gaptimer.eu.

[1] For details see Sicherl (2002), also on possible multiple time intersections; Mueller and Sicherl (2004) and Sicherl (2004a, 2004b, 2004c, 2006b, 2007a).

3. THE NEW COMPLEMENTARY PERSPECTIVE IN TIME SERIES ANALYSIS

Some practical empirical examples of new insights from existing data

The perceptions of well-being and societal progress are subjective, thus the resulting decisions, behavior and actions are influenced not only by the available statistical data and indicators but also by the **measures that are used in the measurement, analysis, presentation and semantics of discussing these issues** as indispensable elements to form these perceptions[2].

S-time-distance measure is one of such measures with clear interpretability that delivers a broader concept to look at data and to compare situations, including benchmarking and monitoring. Empirically, the degree of disparity may be very different in static terms and in time distance**.**

The results and conclusions based on the two-dimensional analysis add a new dimension and new insights for benchmarking, gap analysis, monitoring targets, plans, budgets, projections and scenarios, while none of the earlier results are neither lost nor replaced. The intention is to **complement rather than replace** the conventional static measures of disparity and provide the two-dimensional measurement of the gap as input into an assessment of a broader dynamic notion of the overall degree of disparity. **Gap timing enables additional exploitation of data and visualization for time related databases and indicator systems.** A new set of information with clear interpretability, hidden in the available data, is now provided for policy use over a very large domain of issues due to an added dimension of measurement and analysis.

3.1 BENCHMARKING AND GAP ANALYSIS

Figure 1 demonstrates a broader perception rising from comparing two time series in the two dimensions. 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. The application for the evaluation of the magnitude of the gap in benchmarking analysis in two dimensions in Figure 1 is self-explanatory.

Two time series, in this case GDP per capita for the USA and EU 15 (data from OECD web page, in US$ at constant prices and constant PPP), can and should be compared in two dimensions in order to better exploit the information available in existing time series:

1. static gap at a given point in time, and
2. gap in time for a given value of the variable.

For this specific example of GDP per capita the usual way of comparing the USA and EU15 e.g. in 2005 would be to calculate the static index of 139 or the respective percentage difference. S-time-distance explores another perspective. For the level of EU15 for 2005 one

[2] For more details on perception about measuring progress of societies in the context of OECD World Forum 'Statistics, Knowledge, Policy', i.e. about what (elements of well-being and societal progress) and which measures to use to build perception about them (measures to present and to communicate the topics also for policy making) see Sicherl (2006b and 2007a).

could look into the USA time trend for this indicator and thus find that such level was achieved in the USA in 1987, i.e. the time distance was 18 years. The static ratio of 1.39 does not catch much attention, while the time gap of about two decades obviously adds a different perception of reality.

Figure 1. Two time series can and should be compared in two dimensions

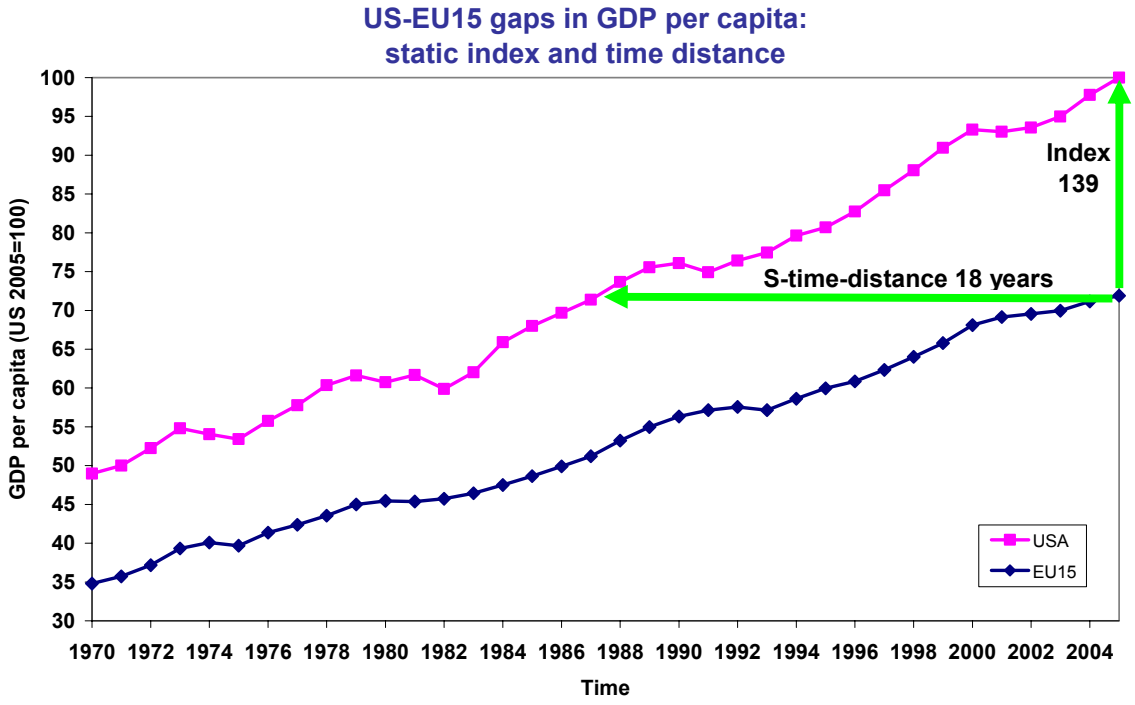
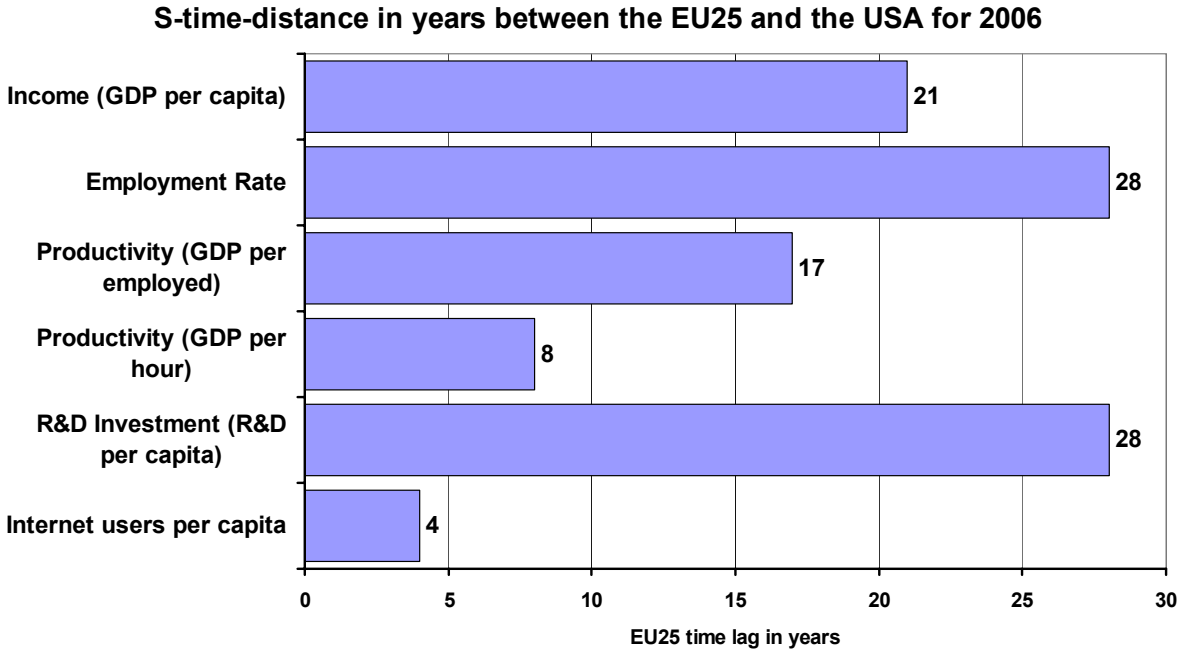


Figure 2.



Source: Sicherl, P. (2007b)

Figure 2 shows estimates of S-time-distances between EU25 and the USA for around 2006 from a study prepared for EUROCHAMBRES (for details see Sicherl 2007b). The time series for EU25 are at present not available for the same length of time than those for EU25, so the trends in S-time-distances cannot be calculated yet for a longer period of time. However, since we are comparing the present position for the EU25 with the past trends for the USA for which long time series are available we can calculate the S-time-distances for around 2006. The results in Figure 2 for R&D per capita relate to 2005 and for Internet users per capita to 2004.

Comparing across indicators we can see that assessing the degree of the gap between the USA and EU15 is very different in static measures and time distance. On the one hand, the static index USA/EU15 for total employment rate was 111, whereas that for R&D per capita was about 180. The perception based on static measure of the gap would indicate that the gap for R&D per capita would be huge compared to the gap for total employment rate. However, S-time-distance was 28 years for both indicators; from the time distance perspective the gap in time is of similar magnitude. The growth rates for these indicators are very different, the total employment rate is growing very slowly in comparison with that of the R&D per capita. While we have to consider both dimensions, the respective static index would seriously underestimate the difficulty in closing the gap with the USA for total employment rate. The S-time-distance estimates better reflect the reality that the reduction of the gaps with the USA would be most difficult for these two indicators, that is, total employment rate and R&D per capita. They are much higher that the time distances for the presented productivity indicators and for the Internet users per capita[3].

The theoretical hypothesis that the perception of the degree of disparity in time may be very different from that in static terms is confirmed also by comparing two different indicators (gender life expectancy and digital divide for selected age groups in the EU15). Again the hypothesis holds true both for each of the indicators separately and across the two indicators.

A drastic example of this can be found in comparing the EU15 for male-female differences in life expectancy, as an important but slowly growing indicator, and the delay in Internet usage for the age group 50+ behind that of total population, as an example of a very fast growing indicator. In the EU15 in 2000 the female life expectancy was 6.3 years higher, which amounted to about 8 percent difference in relation to that of men[4]. However, the time distance was an astonishing 29 years. This means that women attained the male life expectancy for 2000 already in 1971, about three decades ago. The perception whether the gender difference in life expectancy in the EU15 is large or small depends on the measure used: static percentage difference is only 8 percent, while S-time-distance amounts to 29 years.

With respect to the percent of Internet usage in April 2002, the value for total population was 50.27 percent, while that for the age group 50+ amounted to 25.05 percent[5]. The former category had a 100 percent higher value, or the latter attained only 50 percent of the former. But the time distance was only about 1.6 years (19 months), due to the very high growth rates of Internet usage. The perception as to whether the digital divide (age group 50+ with average Internet usage) in the EU15 is large or small depends on the measure used: while static

[3] For a more detailed discussion of the USA-EU15 gap in various indicators see Sicherl (2007a).
[4] Own calculations based on data by Eurostat.
[5] Own calculations based on data from the survey in the SIBIS project, the detailed description of the definition of the disadvantaged groups is found in Selhofer and Huesing (2002).

percentage difference of 101 percent is very large, the S-time-distance amounts only to about one and a half year.

Figure 3.

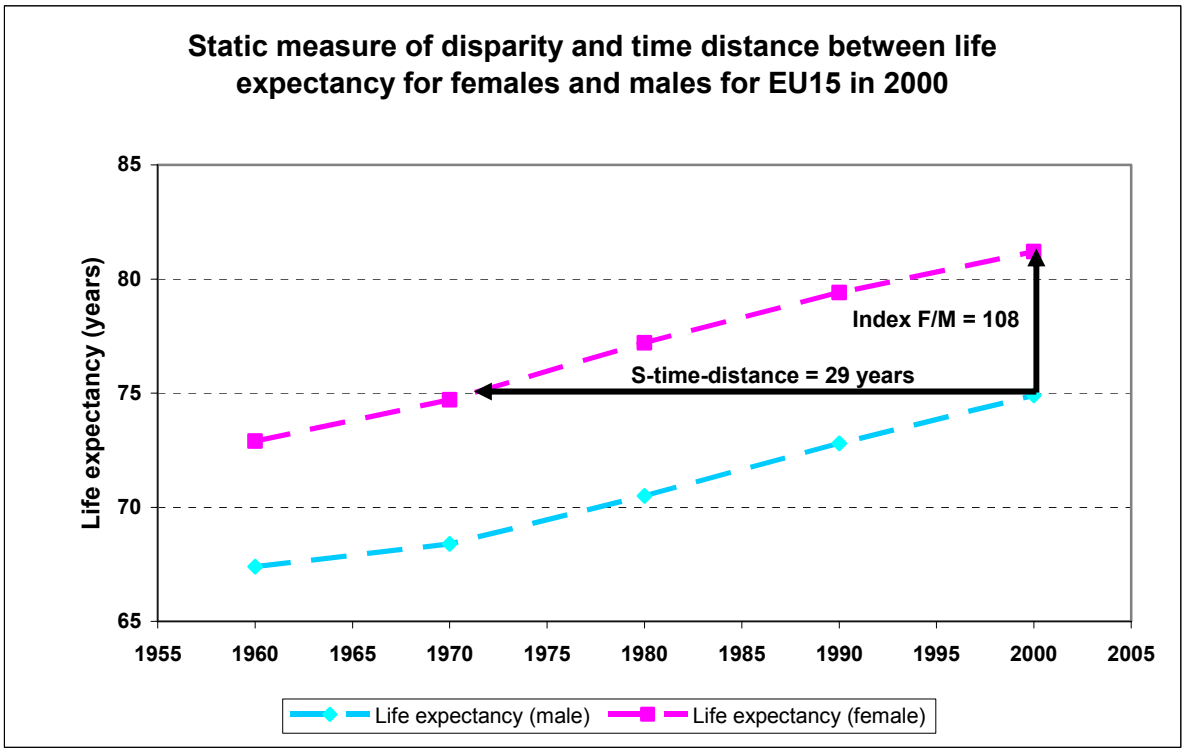
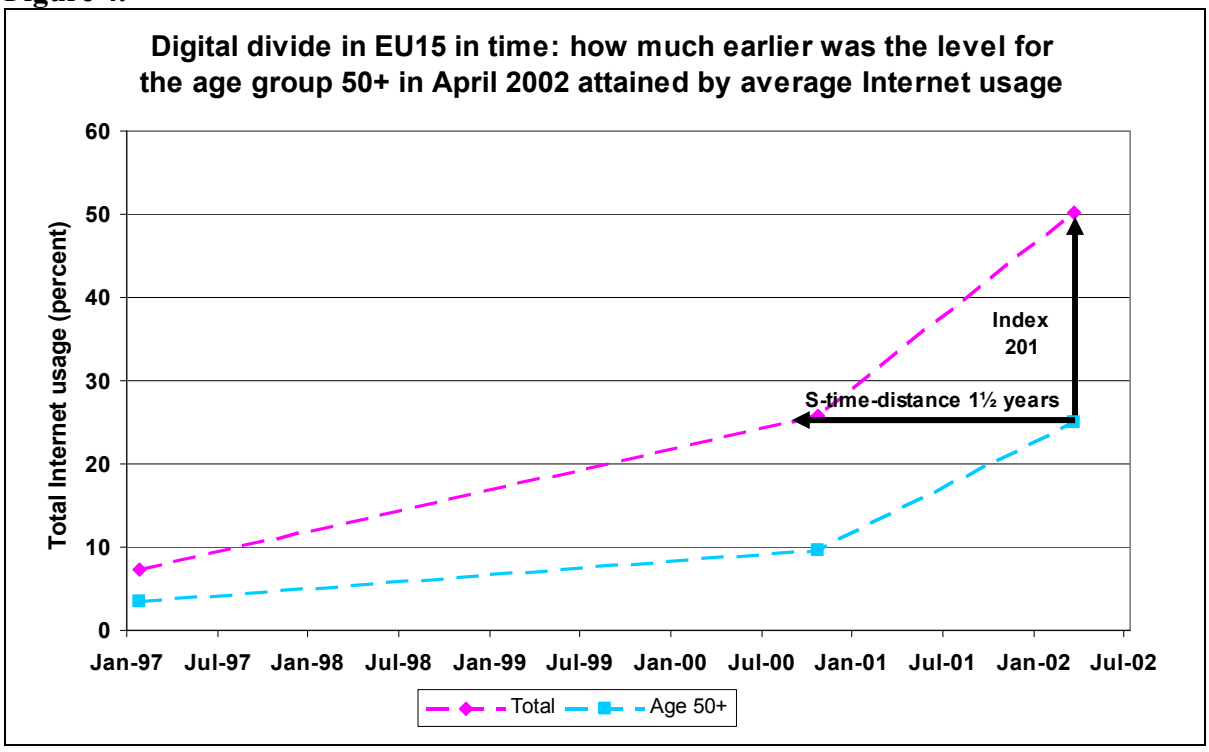


Figure 4.



For a more realistic conclusion all measures should be presented simultaneously. This is important for analysis and policy debate for a single indicator and especially for comparisons across different fields of concern.

Without a more complex subjective evaluation of various options there is no unique judgment about societal progress. We can conclude that the addition of S-time-distance measure without any doubt increased the 'objective' elements on the basis of which people could understand the situation better and form their own perception in line with their preferences. The comparisons across many indicators and fields of concern form the essence of quantitative work in shaping perceptions when assessing the overall "position" and "progress". It has been shown that in comparisons across a number of indicators S-time-distance in many cases produces different and sometimes very surprising new qualitative conclusions.

This is an advantage deriving from a broader theoretical framework explained earlier which additionally exploits some information on the time dimension that is present in existing databases but neglected by the present state-of-the-art. In this framework overall degree of disparity between two units for a given indicator is a weighted combination[6] of static and time distance measures, the perception depending on the subjective weights given to them.

3.2 THE COMPARISONS BETWEEN ACTUAL AND ESTIMATED VALUES: MONITORING IMPLEMENTATION OF TARGETS AND THE EVALUATION OF GOODNESS-OF-FIT IN REGRESSIONS, MODELS AND FORECASTING

Before turning to the main focus of this paper, i.e. application to the implementation of the Lisbon strategy and NRP, we shall briefly indicate one of the possible further developments of the generic idea for applications to measuring deviations between estimated and actual values in regressions and models, forecasting, etc. Figure 6 shows an example of using it as a measure of goodness-of-fit in two dimensions. In the two-dimensional presentation of deviations of actual values from the estimated (planned, budgeted, projected, targeted, etc.) values, or vice versa, the variety of categories and the semantics is enhanced. The respective values are now not evaluated only as too high or too low, there are four possibilities: too high and too early, too high and too late, too low and too early, and too low and too early.

The example in Table 6 of the Consensus forecast and actual growth rate of GNP deflator for USA for the period 1973-1985 presents the deviations in the two dimensions. The conventional methodology would find these Consensus forecasts unbiased as far as high and low estimates are concerned. However, this methodology finds Consensus forecasts for USA inflation rate for the analysed period biased as they are practically always too late for a given level of the indicator. If new insights can be unfolded in such an important case and for results of the most important USA forecasting institutions for this period, such example clearly indicates the potential of this methodology to provide new insights from the existing data for a

[6] The value judgment that people attach to the time dimension of disparities and to the static dimension of disparity is an open question for interdisciplinary research. However, it may be safe to assume that a situation with 50 per cent static difference and time distance of 10 years is preferable to the situation with the same static difference and time distance of 40 years. Such result is indicated in an example of what would happen to the degree of disparity in case the rate of growth of an indicator would increase from one period to another from 1 per cent to 4 per cent, and the static measure of the gap would be 50 percent in both cases. For the reason of simplicity it is assumed that the growth rate would be the same for the two compared units. The conventional analysis based on ratios, percentage differences, Gini coefficients or Theil indexes alone does not distinguish such situations as different degrees of disparity (Sicherl, 2006b, 2007a).

variety of situations at least as a diagnostic tool for estimations of regressions, models and forecasts.

Figure 5.

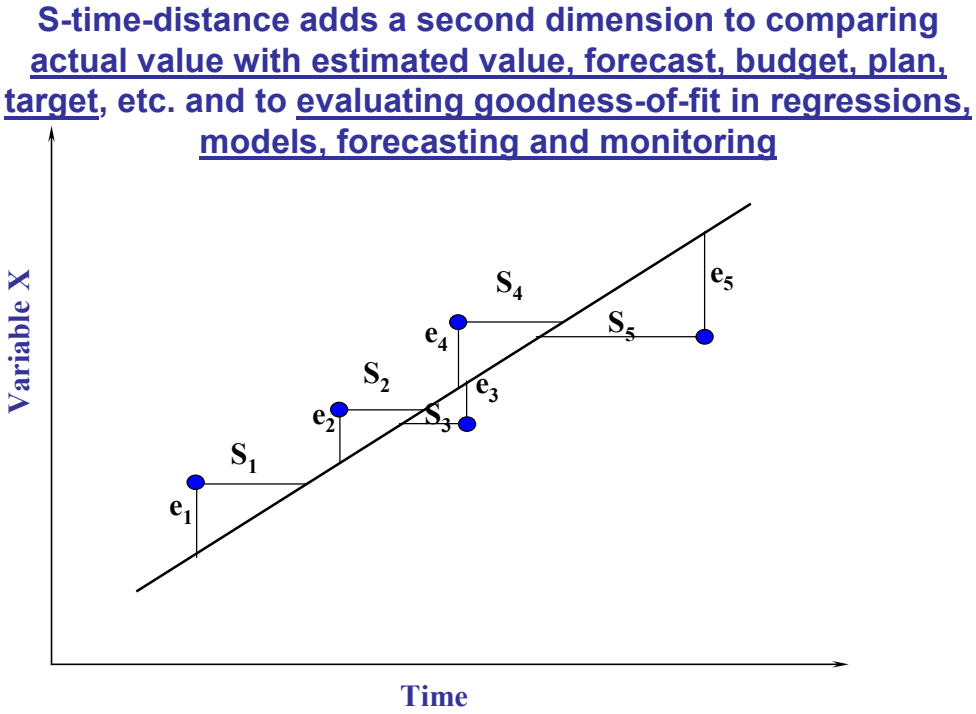
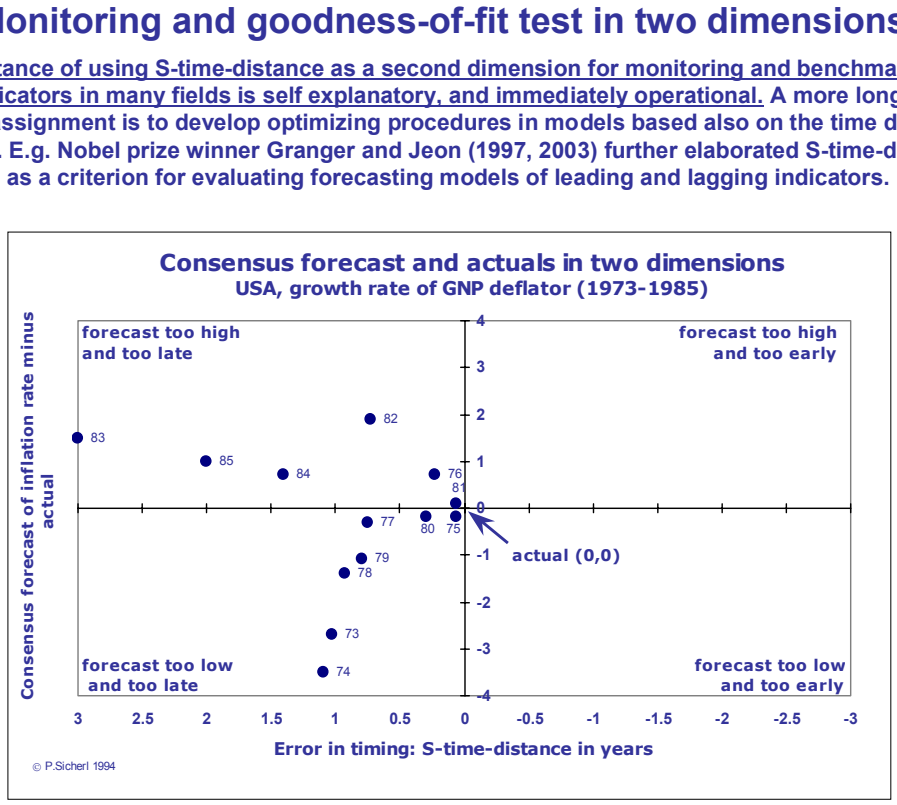


Figure 6.



Since events are dated in time, in time series comparisons, regressions, models, forecasting and monitoring, the notion of time distance has always existed as a "hidden" dimension. What was needed was to systemize and formalise the concept and define an appropriate statistical measure for the operational use. In this paper we shall apply the S-time-distance methodology in a limited way mostly to the international comparisons for development indicators. In this domain S-time-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, 1996, 1997), to variables other than time Sicherl (1999). Granger and Jeon (1997, 2003) extended it to comparisons of leading and lagging indicators and used the time distance as a criterion for evaluating forecasting models[7].

4. MONITORING IMPLEMENTATION OF LISBON STRATEGY IN THE TIME DIMENSION[8]

The main focus of the empirical part of the chapter will be put on monitoring implementation of Lisbon strategy and NRP in the time dimension. S-time-distance is easily understandable by experts, media and general public. This means that in this particular application as an additional measure of implementation it is immediately operational in case policy makers would really wish to follow their proclamations for the need of transparency and better communication with the public.

The position of the Commission is that in building a methodological framework for assessing progress with the implementation of the Growth and Jobs Strategy whenever possible the qualitative assessment will be accompanied by a quantification drawing on available quantification techniques (European Commission, 2006). The S-time-distance is a new technique with clear interpretability that is now available to complement other techniques.

This immediate application to **monitoring the implementation** of the Lisbon strategy in two dimensions can easily be understood by everybody. Targets are usually expressed not only in terms of the indicator values but simultaneously also in time. As processes towards their implementation are related to time, it is very natural and useful to describe e.g. the degree of implementation in two dimensions: 1 per cent below the line to target at a given date, and 2 months behind in terms of the achieved level as against the time foreseen for that actual level on the line to target. In other words, the target line (estimate) is 1 per cent too high and 2

[7] '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).

[8] This section is predominantly based on Sicherl P. (2007d), Monitoring implementation of the Lisbon strategy and NRP in time dimension, Paper presented at the 10th IMAD and 38th CMTEA Joint International Conference 'National Reforms for the Implementation of the Lisbon Strategy: their monitoring, assessment and impacts', Kranjska Gora, Slovenia, June 14-16, 2007. An earlier version (Sicherl 2006a) served as invited presentation at the 2nd Meeting of the Economic Policy Committee Task Force on Structural Indicators in Brussels.

months too early. Generally speaking, whenever there are two series with time subscripts, e.g. actual value and estimated (forecast, budgeted, planned, targeted, etc.) values, it is possible to study deviations in two dimensions: deviation in the indicator space (at a given point of time) and deviation in time (for a given level of the indicator).

There are alternative ways of expressing these matters, but it is obvious that the interpretation for how to overcome the time delay may be a very relevant additional practical procedure to be routinely applied to a large number of physical and financial indicators before turning to the more complicated programs. The use of the additional measure of deviation of the actual implementation from the plan, budget, target or forecasts at a project or activity level is straightforward and at this point does not need any further elaboration. It is especially useful in the cases where the targets are clearly established and/or the monitoring is already a legal or administrative requirement. This can be a standard procedure in numerous other activities of the Commission and of national institutions like monitoring and evaluation of implementation of structural funds policy and of development plans, as well as for the relevant budgets.

The time distance information seems to be at least as helpful in providing a proper perception of the progress in implementation or the lack of it as the percentage difference as shown for selected examples of monitoring the deviations of the actual development from the Lisbon targets in two dimensions for a few indicators provided below.

4.1 LISBON 1 TARGETS SETTING

In discussing the target setting and monitoring of the Lisbon strategy we are essentially dealing with two cases. One is the Lisbon strategy proclaimed in 2000 within a EU15 framework, while its re-launch with National Reform Programmes has been done within the EU25 framework. In order to simplify the discussion we shall use the labels Lisbon 1 and Lisbon 2, as it was done by Pisany-Ferry and Sapir (2006).

At its time Lisbon 1 was courageous, ambitious and was providing a vision in the right direction of the knowledge-based society. However, the implementation in the first four years was disappointing. While the most important reasons for this have been the lack of political will for reform and lack of co-ordination at various levels, there were also two omissions in the preparation of the strategy. One was the over-optimistic assessment of the European position and lack of clarity about the degree of change needed; the other was that not enough attention has been paid to raising public awareness of the issues and challenges involved. This was probably due to the lack of co-ordination between politicians and professionals in dealing with the usual conflict between desirability and feasibility.

If Commission services would had used the time distance estimate of the lag of EU15 behind the USA, for GDP per capita the time lag in 2000 could had been established at about 15 years. To cut a lag of 15 years to nothing in a decade demands a very large difference in the growth rate of GDP per capita in favour of EU15 over that in the USA. This growth rate in the EU15 would have to be 3.3 percent higher than in the USA to achieve that. In the 1990's the GDP per capita in the USA grew at about 2.2 percent per year. If this rate would continue in the following decade, the EU15 respective growth rate would have to be about 5.5 percent per year to converge with the USA GDP per capita in 2010.

This was also clearly inconsistent with the Lisbon 1 target that GDP in the EU15 would grow at about 3 percent per year. Such an obvious gap between desirability and feasibility (5.5 percent needed yearly increase against projected 3 percent) has been damaging to the credibility of the program. Such mistakes could have been prevented, had there been more attention paid to involve the men on the street by explaining the starting position and the target setting, that is, by raising awareness about it to the general public.

As mentioned before, degree of disparities may be very different in static terms and in time. Policy makers, managers, professionals, media and the general public can easily understand the S-time-distance measure. This makes it not only a transparent analytical measure but also an excellent presentation and communication device, which is of great importance for its practical use and which could have considerable influence on public opinion[9].

4.2 IMPLEMENTATION OF LISBON 1 TARGETS AT THE EU AND NATIONAL LEVELS

Commission services and national institutions could use the S-time-distance measure and concept as an important additional analytical and presentation tool in many domains, in the case related to Lisbon and Jobs and Growth Strategy for benchmarking, monitoring and for communication with policy makers, media and general public. Here we shall demonstrate the usefulness of time distance for the monitoring process. We use the two-dimensional example of monitoring the implementation of Lisbon 1 targets in the period 2001-2005. This will serve two purposes. Firstly, it will show the implementation performance of Lisbon 1 for EU15. Secondly, it will be an example of how the Lisbon 2 targets could be monitored in two dimensions when the results for other years are becoming available. Similar application for monitoring the UN Millennium Development Goals on the world scale is provided in Sicherl (2007c).

Table 3 illustrates the methodology of monitoring implementation of the Barcelona target in two dimensions and presents the results for the period 2001-2005. For the implied path to target of 3 percent in 2010 one can simply use a linear interpolation between the starting actual 1.92 percent in 2000 and the final point 3 percent in 2010 (or any other more specific path to target). The deviations are described in two dimensions: percentage deviation and S-time-distance. For S-time-distance minus sign denotes that the actual value is ahead of path to target whereas plus sign means how many years (or months, etc.) actual values are lagging the same value on the path to target line. The numerical results show that by 2005 little progress towards the Barcelona target was achieved. The actual value for 2005 was more than 22 percent below the value on the implied path to target. This is one way to express the degree of underperformance over the five year period.

S-time-distance presents another complementary way of comparing path to target with actual performance in the time dimension. The actual values for 2004 and 2005 were by the latest

[9] This is why the results of my studies for EUROCHAMBRES Sicherl (2005, 2007b) has been such surprise and has been widely reported in the world press. It is an example how social partners, in this case business associations, can use the new time distance perspective on statistical data for policy debate at international and national levels. This confirms that S-time-distance is not only a novel generic statistical measure but also an excellent presentation and communication tool for policy use and that it can influence public opinion.

data from Eurostat at the level which was lower than that in the starting year in 2000. This means that the time delay behind the path to target is more than 5 years for the period of duration of 5 years, i.e. that by 2005 practically no continuous progress towards Barcelona target was achieved.

Table 3.

Monitoring attainment of Barcelona target for EU15 in two dimension

	Share of R&D in GDP (%)		Monitoring deviations of actual from path to target in two dimensions	
	Implied path 1 to target 3%	Actual EU15	Percentage deviation of actual from path to target	S-time-distance deviation of actual from path to target (in years)
2000	1.92	1.92	0.0%	0.0 years
2001	2.03	1.94	-4.3%	0.8 years
2002	2.14	1.95	-8.7%	1.7 years
2003	2.24	1.93	-14.0%	2.9 years
2004	2.35	1.91	-18.8%	more than 4 years
2005	2.46	1.91	-22.4%	more than 5 years
2006	2.57			
2007	2.68			
2008	2.78			
2009	2.89			
2010	3.00			
S-time-distance in years: - actual ahead of path to target, + actual behind the path to target				

Table 4.

Monitoring deviations of actual from path to target in time distance for EU 25 and EU15 for Lisbon 1 targets for 3 indicators

	S-time-distance deviation of actual from path to target (in years) EU25			S-time-distance deviation of actual from path to target (in years) EU15		
	Share of R&D in GDP (%)	Employment rate (%)	GDP Level	Share of R&D in GDP (%)	Employment rate (%)	GDP Level
2000	0 years	0 years	0 years	0 years	0 years	0.0 years
2001	0.7 years	0.5 years	0.3 years	0.7 years	0.1 years	0.4 years
2002	1.7 years	1.5 years	0.9 years	1.6 years	0.8 years	1.0 years
2003	2.7 years	2.3 years	1.5 years	2.6 years	1.6 years	1.6 years
2004	4 years	2.8 years	1.7 years	3.9 years	2.0 years	1.9 years
2005	5 years	3.2 years	2.1 years	5 years	2.3 years	2.4 years
2006		3.4 years	2.1 years		2.3 years	2.5 years
S-time-distance in years: - actual ahead of path to target, + actual behind the path to target						

Table 4 shows the results of monitoring the Lisbon 1 target also for employment rate and GDP growth. For the indicator total employment rate the path to target was calculated by assuming the 70 percent employment rate target in 2010 and for GDP growth rate of 3 percent per year, using the same methodology and procedure as explained for Table 3.

Comparison across three important indicators of implementation of Lisbon 1 targets shows two major conclusions. Firstly, according to both monitoring measures used the underperformance has been considerably larger for the indicator share of R&D in GDP than for the indicators growth rate of GDP and employment rate. The performance expressed as the delay in time was more than 5 years for the share of R&D in GDP and more than 2 years for the other two analysed indicators. S-time-distance expressed in standard units – time – delivers a very clear and practical message about the situation.

Secondly, if one would compare the underperformance for employment rate and GDP growth rate it could be shown that the percentage deviation and S-time-distance deviation from the path to target do not lead to the same conclusion. In percentage terms the gap in GDP appears to be considerably greater than that for employment rate, while S-time-distance measure estimates the delay behind the respective paths to target for both indicators at more than 2 years.

The empirical examples for EU15 and EU25 are extended for the case of employment rate to all 25 countries and for female employment rate for the case of Belgium regions.

Table 5.

Lisbon 1 target of 70% employment rate in 2010 for all countries
(deviations in the time dimension from the hypothetical path to target)

S-time-distance in years

	2000	2001	2002	2003	2004	2005	2006
EU (25 countries)	0	0.5	1.5	2.3	2.8	3.2	3.0
EU (15 countries)	0	0.1	0.8	1.6	2.0	2.3	2.1
Denmark		target 70% total employment rate already achieved					
Netherlands		target 70% total employment rate already achieved					
Sweden		target 70% total employment rate already achieved					
United Kingdom		target 70% total employment rate already achieved					
Austria	0	1.0	0.7	0.3	0.0	4.3	
Cyprus	0	-3.9	-4.7	-5.1	-3.4	-1.5	-3.8
Estonia	0	0.4	0.3	0.4	1.3	0.8	-2.0
Finland	0	-2.2	-1.2	1.2	2.6	0.7	-1.5
Ireland	0	-0.2	1.4	2.4	1.7	0.0	-1.1
Latvia	0	0.1	-0.3	-0.4	0.2	0.4	-1.0
Spain	0	-0.1	0.4	0.4	0.5	-0.1	-0.2
Slovenia	0	-0.4	1.2		0.5	0.6	0.7
Lithuania	0		1.3	1.2	2.1	1.8	1.9
Germany	0	0.5					2.4
Greece	0	1.1	1.3	1.4	1.9	2.3	2.7
Italy	0	0.3	0.9	1.5	1.6	2.6	3.1
Slovakia	0	1.0	2.0	2.3	3.8	4.3	4.0
Luxembourg	0	0.5	1.0			3.8	4.8
France	0	0.1	0.9	1.5	2.7	3.7	4.9
Hungary	0			2.5	3.6	4.6	5.3
Czech Republic	0	1.0	1.2				5.4
Belgium	0					4.4	5.5
Malta	0	0.9	1.9	3.0			5.6
Portugal	0	-2.7	-0.5				
Poland	0						

S-time-distance in years: - actual ahead of path to target, + actual behind the path to target

values fell below the starting 2000 value

target 70% total employment rate already achieved

Table 6.

Lisbon 1 target of 60% female employment rate in 2010 for all regions, BELGIUM

(deviations in the time dimension from the hypothetical path to target)

S-time-distance in years

	2001	2002	2003	2004	2005
Prov. Vlaams Brabant	0	0.9	1.9		
Prov. Oost-Vlaanderen	0	0.9	1.9	1.2	
Prov. Antwerpen	0	0.3	1.1	1.2	1.3
Prov. West-Vlaanderen	0	0.2	1.4	1.0	1.6
Prov. Liège	0	1.0	0.9	2.1	1.8
Prov. Namur	0	1.0	1.0	2.0	1.9
Prov. Hainaut	0	0.6	0.0	2.0	2.0
Prov. Limburg (B)	0	0.6	2.5	2.5	3.1
Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest	0	0.0	1.5	2.2	3.2
Prov. Brabant Wallon	0	2.8	1.9	3.3	3.5
Prov. Luxembourg (B)	0	2.3	4.0	3.9	3.9

S-time-distance in years: - actual ahead of path to target, + actual behind the path to target

values fell below the starting 2000 value

target 60% female employment rate already achieved

In benchmarking and monitoring there are now two 'objective' measures available, which can help the public to form a subjective perception of the magnitude of the gap for a given indicator as well as across more indicators. Decision makers, professionals, interested groups and general public might attach different subjective weights to various elements on the basis of which they will form their perception and action. The first question is how they weight their subjective importance given to the different domains like employment or GDP; the second question for a given indicator is what subjective weights are given to the gap in static percentage terms and to the time distance gap. These are the questions beyond the purpose of this paper. The possible role of the time distance measure in the inter-temporal aspect of measuring well-being and societal progress is discussed in Sicherl (2006b and 2007a).

4.3 LISBON 2 AND R&D INTENSITY TARGETS

The delay in the implementation of the Barcelona target is much larger than that for the employment rate also at the national level. By 2005 only Sweden and Finland already achieved the 3 percent target and only three more countries have less than three and a half year delay against the line to target; for seven of them their 2005 values are even lower than the starting values in 2000 (Sicherl 2007d).

The re-launch of the Lisbon agenda with new targets in the National Reform Programmes (NRP) raises an interesting question of how does the aggregate of the national targets relate to the Barcelona target for the share of R&D in GDP. The new national targets are weighted by the GDP weights from 2004 for EU15 countries to arrive at an approximate target of 2.6 percent of GDP in 2010. Introducing national targets increased realism but decreased ambition. In Figure 7 the new line to target for Lisbon 2 is calculated by linear interpolation between 2004 actual and the weighted values of national targets for 2010. Though lower than the Barcelona target, it is important to understand the order of magnitude of the challenge undertaken by Lisbon 2 targets. However, only time will tell whether the far-reaching improvements implied in these targets could still be put into action.

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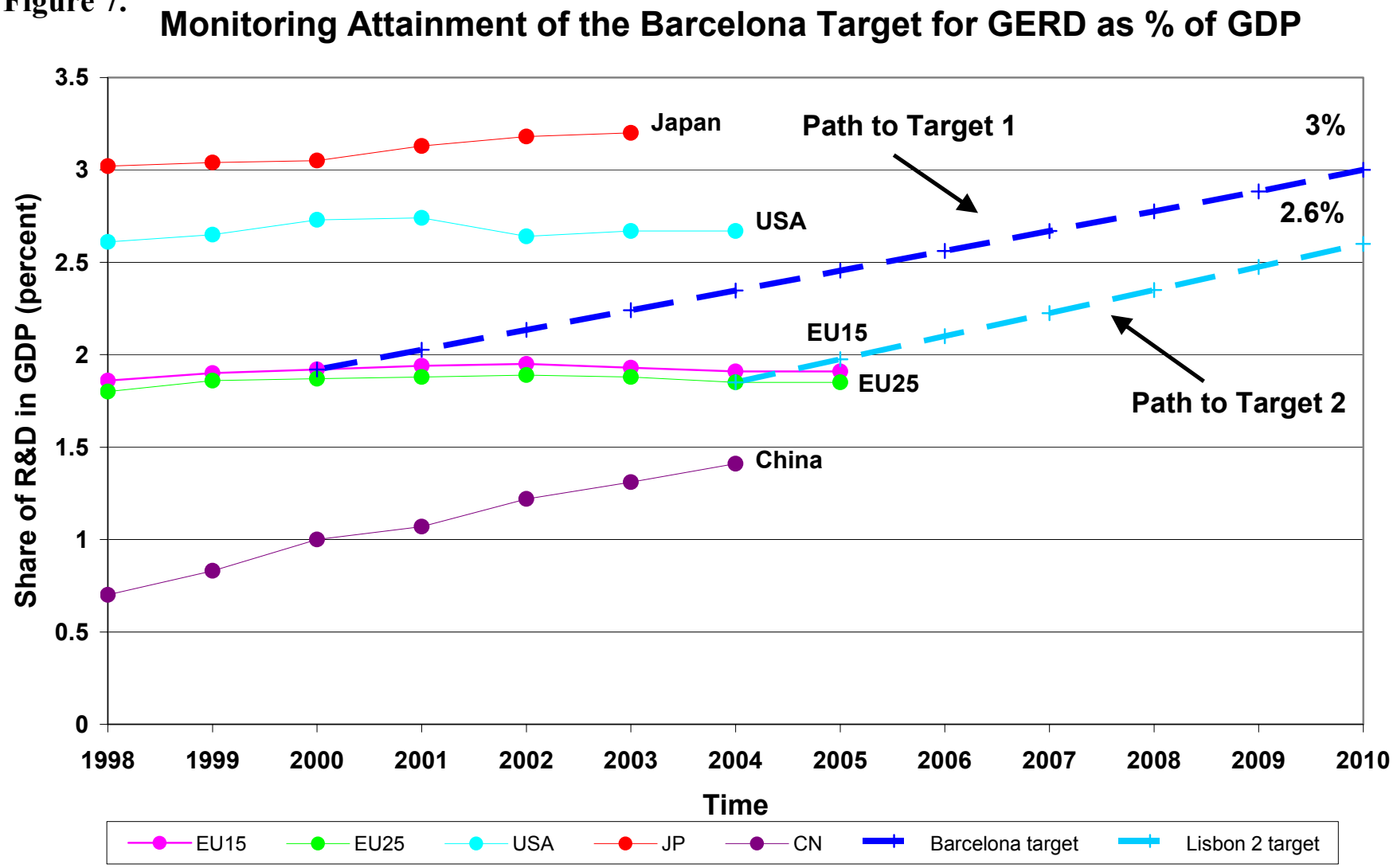
Figure 7.



For the share of R&D in GDP data are available only for 2005 (for three countries they are still missing); the actual values for 2005 are then compared with this implied time-table to the national targets. The big problem is the implementation of so reduced national targets for Lisbon 2. For EU25 total estimates look bad again; there was no increase in 2005, which means a delay of 1 year in the 1 year period. Only three countries were in 2005 ahead of their own line to target (Sweden, Czech Republic and Austria), for 18 countries the minimum delay expressed as S-time-distance was 7 months in a year, for some 2005 value was less than for 2004. Moreover, China is approaching fast. Therefore, it is even more important that a continuous monitoring system is to be put in place as soon as possible.

Table 7.

Implementation of national targets for the R&D share in GDP in 2005

(deviations in the time dimension from the hypothetical path to target)

S-time-distance in years					Level	Target
	2004	2005	Delay in 2005 expressed in months		Starting share in 2004 (%)	National target for 2010 (%)
EU (25 countries)	0	1	12.0		1.86	2.6*
EU (15 countries)	0	1	12.0		1.92	2.6*
Sweden	0	-1.77	(-21.24)		3.74	4
Finland	0	0.78	9.4		3.46	4
Germany	0	0.88	10.6		2.5	3
Denmark	0		more than 12		2.48	3
Austria	0	-0.01	(-0.12)		2.23	3
France	0		more than 12		2.14	3
Belgium	0		more than 12		1.89	3
Luxembourg	0		more than 12		1.66	3
Slovenia	0		more than 12		1.45	3
Czech Republic	0	-0.2	(-2.4)		1.26	2.06
Ireland	0	0.72	8.6		1.21	2.07
Spain	0	0.62	7.4		1.06	2
Hungary	0	0.61	7.3		0.88	1.8
Estonia	0	0.65	7.8		0.88	1.9
Portugal	0	0.77	9.2		0.77	1.8
Lithuania	0	1	12.0		0.76	2
Malta	0		more than 12		0.63	0.75
Greece	0	0.8	9.6		0.61	1.5
Poland	0	0.96	11.5		0.56	2.09
Slovakia	0	1	12.0		0.51	1.8
Latvia	0	0.17	2.0		0.42	1.5
Cyprus	0	0.71	8.5		0.37	1
Netherlands	0	no data	no data		1.78	3
United Kingdom	0	no data	no data		1.77	2.21
Italy	0	no data	no data		1.1	1.9

S-time-distance in years: - actual ahead of path to target, + actual behind the path to target

values fell below the starting 2004 value

This paper offers a blueprint of an improved extended monitoring system that could be used across countries and regions as well as across indicators. The example in Table 8 for Austria as one of the 25 country tables (now 27) can serve as template for any selected indicator. For 2005 and 2006 the estimates of the share of R&D in GDP for Austria are already available by Eurostat. The implied path to the Lisbon 2 target is linear extrapolation for each country from its actual value in 2004 to the proclaimed target in 2010. Austria is thus very close to the track. Such tables and the accompanying procedures could be prepared in advance.

When the values for 2006 and later years become available for other countries and other selected structural indicators, the innovation with the expanded monitoring system in two dimensions as an additional presentation tool could be in place. Such table as for Austria would be multiplied by 25 (27) and by the number of indicators analyzed. These results can be then compared across countries for a given indicator and across indicators for a given

country. They can be also used also as an input for further processing with statistical and mathematical models.

Table 8.

Template for monitoring implementation in two dimensions against NRPs specified targets at relevant levels: national, EU and sub-national (regional, socio-economic groups) *(25 countries times number of selected indicators)*

Example: monitoring deviations of actual from path to target in two dimensions, AUSTRIA, Lisbon 2 target for R&D share in GDP

	Share of R&D in GDP (%)		Monitoring deviations of actual from path to target in two dimensions	
	Implied Lisbon 2 path to target 3%	Actual	Percentage deviation of actual from path to target	S-time-distance deviation of actual from path to target (in years)
2005	2.36	**2.36**	**0%**	**0 years**
2006	2.49	**2.43**	**-2.3%**	**0.44 years**
2007	2.61			
2008	2.74			
2009	2.87			
2010	3.00			
S-time-distance in years: - actual ahead of path to target, + actual behind the path to target				

Sicherl (2007c, 2007e) present empirical results obtained when this monitoring methodology is applied to the analysis of the implementation of the UN Millennium Development Goals in the time dimension. The examples for the selected 9 indicators from the four goal domains for world regions and for China (as an example for a single country) provided in simple understandable terms interesting conclusions across the fields of concern for the analyzed regions and across world regions for those indicators. For infant mortality rate the lead or lag in time from the line to MDG target for each of the 113 countries has been estimated for 2004 to indicate the capabilities of the methodology for monitoring implementation of targets over a large number of countries.

A substantial effort of the international and national organizations has been and will be channeled into collecting the necessary data for the related system of indicators. However, availability of data and faster computer processing are expanding at an unprecedented pace, but the benefit for better decision making and wide participation will depend critically on the human interface: understanding of the information and communication of that understanding (Sicherl, 2006b). If the relevant EU and national bodies would care to assess the S-time-distance measure by the same eight criteria applied to the selection of structural indicators like 1. Easy to understand, 2. Policy relevant, 3. Mutually consistent,… 6. Comparable between countries, etc. (Munoz 2004), then for this application in monitoring implementation of EU and NRP strategies the S-time-distance measure would pass the test with flying colours.

5. CONCLUSIONS

1. The first conclusion is methodological. The novel generic S-time-distance concept and statistical measure offers a very interesting new way of analyzing and presenting time series data. It provides new information from existing data. The time perspective, which without any doubt exists in human perception when comparing different situations, is systematically introduced both as a concept and as a quantifiable measure in statistical and comparative analysis. The new view of information, using levels of the variable(s) as identifiers and time as the focus of comparison and numeraire, **is theoretically universal, intuitively understandable and can be usefully applied as an important analytical and presentation tool** to a wide variety of substantive fields at macro and micro levels.

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

S-time-distance measure is a measure with clear interpretability that delivers a broader concept to look at data and to compare situations, including benchmarking and monitoring. **Empirically, the degree of disparity may be very different in static terms and in time distance. This innovation opens the possibility for simultaneous two-dimensional comparisons of time series data: vertically (standard measures of static difference) as well as horizontally (Sicherl time distance).**

2. **Time distance is also an excellent presentation and communication tool**. Since S-time-distance is expressed in time units, it is **intuitively understood by policymakers, professionals, managers, media and the general public**, facilitating their subjective perception about their position in this additional dimension. It can be very useful for various levels of decision makers and interest groups for describing different situations, challenges and scenarios, for proactive discussion and presentation of policy and business alternatives to policy makers, managers, media, the general public as well as mobilizing those participating in or being affected by the programs.

3. **A new dimension is added while no earlier results are lost or replaced. The benefits of this new complementary view in comparisons, competitiveness issues, benchmarking, target setting and monitoring** for economic, employment, social, R&D and environment indicators **could be immediately applied to a wide variety of substantive fields at macro and micro levels using existing data and indicator systems.** Here the empirical analysis provides only some examples of immediate operational use of time distance measure relevant for the Lisbon process. However, it could be extended to the world, OECD, EU, country, regional, city, sector, socio-economic groups, company, project, household and individual levels using existing data and indicator systems from international, national, state, city, local and business sources. Its possible applications as the second dimension for analyzing deviations in regressions, models and forecasting are not dealt with in this paper.

4. Possible application for the **evaluation of the magnitude of the gap in benchmarking analysis was demonstrated for the case of unrealistic setting of the target in Lisbon 1.** Such gaps have been damaging to the credibility of the programme. **Had there been more attention to involve the men on the street by explaining the starting position and the target setting by raising awareness of the challenges and explaining them to the general public in understandable terms, such mistakes could have been prevented.**

5. The next example is related to the **monitoring of the implementation** of the Lisbon strategy in two dimensions. Measuring the implementation of the Lisbon 1 targets in the 2001-2005 period, it has been shown that the **Barcelona target for R&D in GDP is about 5 years behind the path to target; for employment rate and GDP growth it is more than 2 years behind the Lisbon 1 targets**. **The time distance information seems to be at least as helpful in providing a proper perception of the progress in implementation or the lack of it as the conventional percentage difference.** Examples are **also** provided for **country and regional performance** against the Lisbon targets.

6. The re-launched Lisbon strategy with national ownership needs continuous monitoring. **Comparison of Barcelona target and Lisbon 2 targets for R&D in GDP** in the National Reform Programmes showed that the exact implementation of the latter would imply that EU15 would reach **around 2.6 percent in 2010**. This value was scheduled to be reached in the early months of 2007 on the original path to target 3 percent. However, **the big problem is implementation of the so reduced national targets for Lisbon 2**, the performance in 2005 was very disappointing. If new Lisbon 2 targets for R&D in GDP for 2005-2010 are compared with the past trends in the period 1998-2005, the outlook for implementing Lisbon 2 targets for this structural indicator is very poor. Europe has to do much better.

7. **In a situation like this it is thus even more important that a continuous monitoring system is to be put in place. This paper offers an improved extended monitoring system that could be used across countries as well as across indicators.** A template with an example for Austria shows that the innovation with the expanded monitoring system in two dimensions as an additional presentation tool could be in place when the values for 2006 and for next years become available for other countries, regions and other selected structural indicators.

8. **These examples demonstrate that usefulness of the innovative time distance concept and measure for operational work of Commission Services and national institutions. Monitoring Lisbon targets and NRP in the time dimension is an excellent presentation tool, intuitively understood by policymakers, professionals, managers, media and the general public, which can also facilitate the broad participation in the Lisbon process.**

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