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# Comparing In Two Dimensions: A Broader Concept and a Novel Statistical Measure of the Time Dimension of Disparity

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**Abstract**

The time perspective, which no doubt exists in human perception when comparing different situations, is systematically introduced in comparative analysis both as a concept and as a quantifiable measure. Existing methods of comparative analysis do not take into account that, in addition to the disparity (difference, distance) in an indicator at a given point in time, in principle there exist a theoretically equally universal disparity (difference, distance) in time when a certain level of the indicator is attained by the two compared units. The novel 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 indicator X.

Definitions of two concepts, degree of inequality and convergence, are broadened by this concept of time distance. The degree of disparities is measured in two dimensions: existing static measures are left unchanged, complemented by proximity in time. This can lead to very different analytical and policy conclusions, also about the interrelationship between growth and inequality.

In the empirical part a selected set of economic and social indicators will be compared for selected candidate and EU countries to investigate how similar or dissimilar are these candidate countries. It is demonstrated that the degree of disparities across indicators may be very different in static terms and in time.

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## 1. Introduction

A distinct feature of this analysis is a two-dimensional evaluation of disparities among countries: the conventional static measures of disparity at a given point in time are complemented, not replaced, by time distance when the same level of the indicator was reached by the compared countries. Section 2 provides the operational definition and some theoretical hypotheses. In the empirical part Section 3 illustrates time distances of candidate countries behind EU15 average for GDP per capita. Section 4 comparing Slovenia with several EU countries and Section 5 comparing selected EU and candidate countries demonstrate the additional analytical and policy conclusions beyond those that can be arrived by conventional measures of disparity. Section 6 illustrates that the conclusions about convergence or divergence should also be evaluated in two dimensions: in time and in the indicator space. The shortest description of benefits of the new approach is new insight from existing data, as a new dimension is added while no earlier results are lost or replaced

## 2. Methodology: adding time distance analysis to conventional measures

Time is one of the most important reference frameworks in a modern society. Existing methods in economics and statistics do not fully utilise the information content with regard to certain aspects of the time dimension embodied in the analysed data. The novel methodology for analysing disparities in economic and social indicators shows that the degree of disparities may be very different in static terms and in time. This means that new insights can be provided from existing data.

First, a broader theoretical framework is required. Time distance concept and methodology represent an inherent dimension in comparative analysis over time. The conventional approach does not realise that in addition to the disparity (difference, distance) in the indicator space at a given point in time, in principle there exist a theoretically equally universal disparity (difference, distance) in time when a certain level of the indicator is attained by the two compared units. The perception of and the conclusions about the degree of disparity based on two-dimensional analysis of proximity provide a better understanding of the situation. A new dimension is added while no earlier results are lost or replaced.

Time distance in general means the difference in time when two events occurred. We define a special category of time distance, which is related to the level of the analysed indicator. 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 indicator X. The observed distance in time (the number of years, quarters, months, etc.) is used as a dynamic (temporal) measure of disparity between the two series in the same way that the

observed difference (absolute or relative) at a given point in time is used as a static measure of disparity.

For a given level of $X_L$, $X_L = X_i(t_i) = X_j(t_j)$, S-distance is the time separating unit (i) and unit (j) for the level $X_L$

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

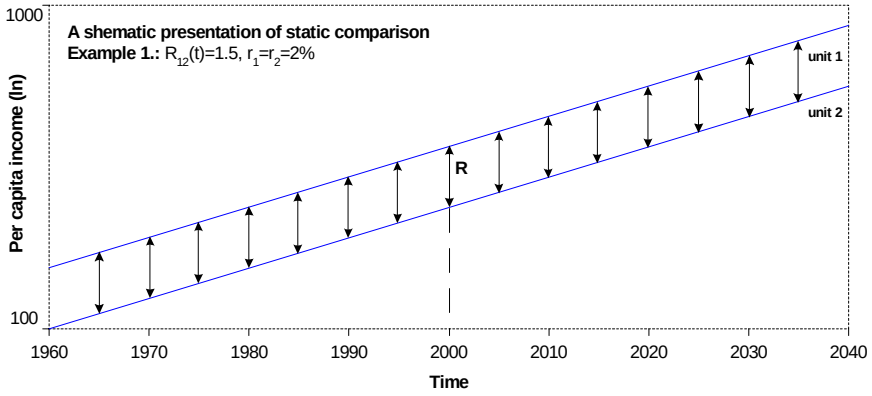
where T is determined by $X_L$. In special cases T can be a function of the level of the indicator $X_L$, while in general it may take more values when the same level is attained at more points in time, i.e. it is a vector which can in addition to the level $X_L$ be related to time ($T_1$, T2...$T_n$). Time distance is a generic concept like relative disparity or growth rate (for more details consult Sicherl, 1998 and 1999a).

One big advantage is that it is defined in standardised units - time - which means that everybody understands the notion of the time lead or time lag between two compared units for a given level of the indicator. 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 of considerable influence on public opinion. There is an important distinction between backward looking (ex post) and forward looking (ex ante) time distances. They relate to different periods, past and future, the first belongs to the domain of statistical measures based on known facts, the second is important for describing the time distance outcomes of the results of alternative policy scenarios for the future (see Section 3).

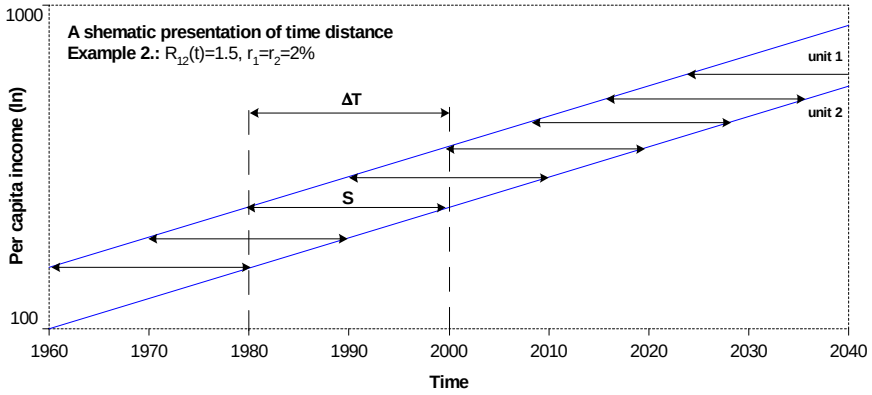
The conventional analysis of disparity is mainly developed for the evaluation of the degree of disparity at a given point in time. This method, however, enables two-dimensional analysis of disparity: the degree of disparity between the two compared units can be expressed simultaneously in at least two dimensions: a static measure (e.g. that per capita product in region 1 was in 2000 50 per cent higher than in region B) and the time distance (e.g. that the time lag amounted to 10 years, as the current 2000 level of the per capita income of region 2 was achieved in region 1 already in 1990). Either cannot in itself describe the complex notion of the overall degree of disparity. The second big advantage of this approach is that the results and conclusions based on the two-dimensional analysis add new information and new insight, while none of the earlier results are lost or replaced. The broader two-dimensional concept of overall degree of disparity can lead to very different analytical and policy conclusions than those based on conventional percentage difference, Gini coefficient or Theil index.

A very important relationship shows that, ceteris paribus, time distance is a decreasing function of the magnitude of the growth rate of the indicator. Let us use a simple example that the rate of growth of the analysed indicator is the same for both compared regions, but different for two scenarios (1 per cent and 4 per cent). The ratio between region 1 and region 2 is 1.5 in both scenarios. Conventional relative static measures would describe these two situations as equal degree of disparity (same value of the ratio in this case of two units or same Gini coefficient in the case of many units). S-distance would amount to 40 years in the low growth case, and 10 years for the 4 per cent growth rate.

**Figure 1. Perceiving and measuring differences in two dimensions (in value and in time)**




**1. Static dimension: difference in value at a given point in time**

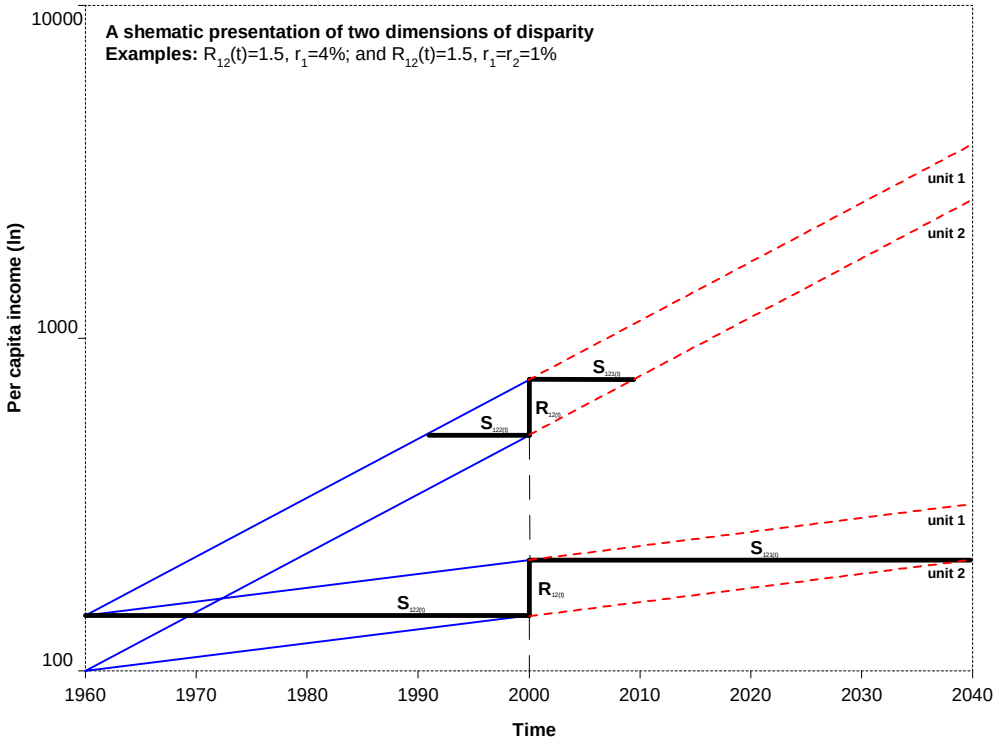



**2. Time dimension: difference in time for a given value of the indicator**

It is highly improbable that people would follow the conclusion of the conventional analysis and perceive these two situations as equal as far as the degree of disparity is concerned, not to mention the difference in the absolute levels. 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.

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 this would be the only benefit of its use, it would be unwise not to take advantage of a new analytical tool. Second, important hypotheses about the interrelationship between efficiency, growth and disparity can be formulated in such dynamic framework with important economic, social and political consequences. This offers improved semantics for analysis and policy debate.

**Figure 2. 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.**

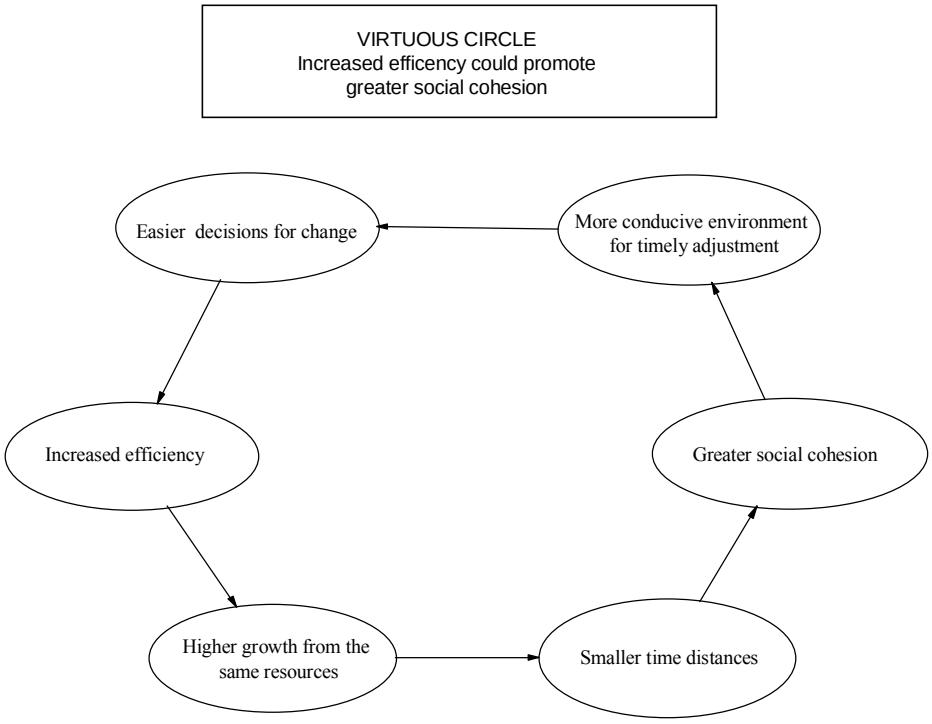
The analytical conclusion that higher magnitudes of growth rates lead, ceteris paribus, to smaller time distances, and vice versa, is important in explaining past developments and in preparing policy recommendations. For instance, for the analysis of convergence and the degree of cohesion in the EU a 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. For instance, scenario A of 5 per cent growth for the less developed countries (regions) and 3 per cent for the more developed countries (regions), on the one hand, and scenario B with 4 per cent and 2 per cent, respectively, will produce the same convergence in static terms, but time distance in catching up with the previous levels of the more developed units will be shorter in the higher growth scenario A. 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.

An action program to reduce disparities and alleviate 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 ($r_2 - r_1$). 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 emphasised. 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 3.**




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.

This brief presentation of time distance methodology is based on Sicherl (2000b and 2001a). A more detailed elaboration of time distance methodology can be found in Sicherl (1999b, 1999c, 2000a, 2000b and 2001b).

## 3. Disparities in GDP per capita between EU15 average and selected candidate countries (ex post and ex ante time distance)

First, as GDP per capita cannot be considered as the only relevant or representative indicator across a whole set of development and welfare issues, this analysis is supplemented by an overview of other indicators presented in Tables 1 and 2. Second, as development is by its nature a long-term and multidimensional phenomenon, in addition to static comparisons at a given point in time special emphasis is given to a dynamic aspect which is presented by time distance as a new statistical measure in comparative analysis. The degree of disparities may be very different in static terms and in time.

The logic of calculation backward looking (historical) time distances can be easily explained by looking at the values for the candidate countries and EU15 in the past (see Figure 4). In 2000 GDP per capita at purchasing power parity for Slovenia was evaluated at 72 per cent of the EU15 average value. In the time series for EU15 one looks for the year in which the EU15 had the same percentage of its 2000 value of GDP per capita as Slovenia had in 2000. This was approximately in the year 1984, which means that the backward looking time distance is about 16 years. In other words, the same value of the analyzed indicator was achieved in EU15 16 years ago (1984 compared to 2000 in Slovenia). The corresponding values are for Czech Republic 28 years, for Hungary 31 years, for Slovakia 32 years, for Poland 38 years and for Estonia 39 years.

Forward looking time distances for the level of EU15 average for 2000 are calculated based on a scenario that GDP per capita for the candidate countries will grow at 4 per cent per year. If this scenario would be implemented, the level of EU15 average for 2000 would be reached by Slovenia at about 2008, which means that at this level of GDP per capita the time distance for Slovenia would be about 8 years. Since we do not have the scenario for growth of GDP per capita for EU15 average in the future, it is not possible to calculate what will be the conventional absolute or percentage difference between EU15 average and Slovenia in 2008. However, under the assumed scenario we have the estimate of one dimension of disparity in 2008, the time distance is expected to be about 8 years. Such scenario tells us that the time dimension of disparity between Slovenia and EU15 average is expected to be reduced from 16 years to 8 years.

## 4. Different perceptions of disparity across various fields of concern based on static measures and on time distance – the case of Slovenia

The comparison of GDP per capita has to be supplemented by other indicators. However, for all selected indicators the necessary data are not available for year 2000. Tables 1 and 2 thus relate to various years around 1998 from an earlier study of position of Slovenia with respect to selected EU countries (Sicherl, Vahčič, 2000), as presented in Sicherl (2001c). Depending on availability of data the tables illustrate the application of comparison of position of Slovenia in two dimensions for 12 selected indicators from different areas of concern: economic indicators (indicators 1-4), demographic indicator (indicator 5), social indicators (indicators 6-7), indicators of communication and information infrastructure (indicators 8-10), indicator of mobility (indicator 11) and indicator of environmental pollution (12). In this summary illustration it is of course impossible due to the lack of space to present all the results of quantitative analysis of the selected indicators.

**Figure 4. Distance in time (projected) at the level of EU15 average GDP per capita for 2000**
**Scenario: growth rate 4% CEEC**

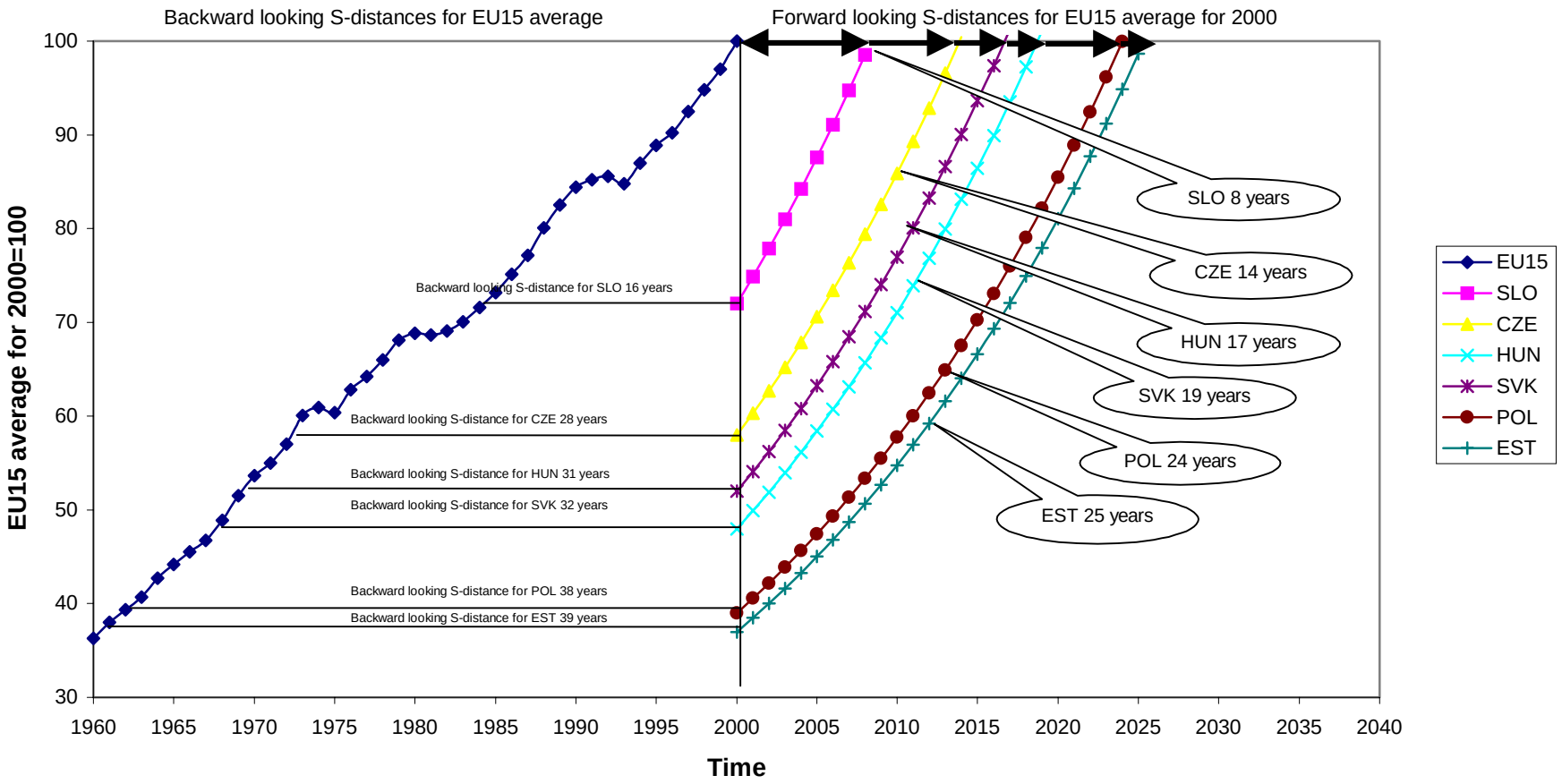


Table 1. **Magnitude of development gaps** between Slovenia and EU15, Austria, Ireland, Finland, Spain, Portugal and Greece **as measured by time distance in years**
(Slovenia=0, for time distance: -time lag of Slovenia, + time lead of Slovenia)

| Indicator | | EU15 | AUT | IRL | FIN | ESP | PRT | GRE |
|---|---|---|---|---|---|---|---|---|
| 1 | GDP per capita (ppp) | -18 | -20 | -7 | -17 | -7 | -1 | 1 |
| 2 | GDP per employed | -17 | -15 | -8 | -9 | -12 | 5 | 0 |
| 3 | Exports per capita | -3 | -10 | -12 | -8 | 5 | 8 | 15 |
| 4 | Imports per capita | -2 | -12 | -10 | -5 | 4 | 2 | 8 |
| 5 | Share of working population | 8 | 7 | 10 | 8 | 6 | 7 | 7 |
| 6 | Life expectancy (female) | -12 | -9 | -2 | -10 | -18 | -1 | -11 |
| 7 | Infant survival rate | 0 | -2 | 4 | -6 | 3 | 4 | 3 |
| 8 | Telephones per capita | -12 | -12 | -2 | -17 | -4 | -2 | -9 |
| 9 | Mobile phones per capita | 0 | -1 | -1 | -3 | 0 | -1 | 0 |
| 10 | Internet hosts per capita | -2 | -2 | -1 | -4 | 1 | 2 | 3 |
| 11 | Cars per capita | -8 | -7 | 5 | 0 | -1 | -2 | 9 |
| 12 | Emissions $CO_2$ per capita | 6 | 26 | 19 | 29 | -1 | -2 | 5 |

Source: Sicherl P. (2001c), Distance in time between Slovenia and the European Union, An example of possible visualisation of time distance results, Working paper, SICENTER, Ljubljana

Table 2. **Magnitude of development gaps** between Slovenia and EU15, Austria, Ireland, Finland, Spain, Portugal and Greece **as measured by percentage difference** around 1998
(Slovenia=0, positive value higher than Slovenia, negative value lower than Slovenia)

| Indicator | | EU15 | AUT | IRL | FIN | ESP | PRT | GRE |
|---|---|---|---|---|---|---|---|---|
| 1 | GDP per capita (ppp) | 47 | 68 | 50 | 50 | 15 | 4 | -1 |
| 2 | GDP per employed | 38 | 48 | 43 | 38 | 26 | -15 | 0 |
| 3 | Exports per capita | 27 | 78 | 271 | 104 | -29 | -36 | -76 |
| 4 | Imports per capita | 15 | 95 | 142 | 43 | -23 | -14 | -54 |
| 5 | Share of working population | -4 | -3 | -6 | -4 | -2 | -3 | -3 |
| 6 | Life expectancy (female) | 2 | 3 | 0 | 3 | 4 | 0 | 3 |
| 7 | Infant survival rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Telephones per capita | 41 | 35 | 13 | 53 | 11 | 5 | 42 |
| 9 | Mobile phones per capita | 20 | 82 | 52 | 161 | 21 | 69 | 25 |
| 10 | Internet hosts per capita | 71 | 103 | 56 | 700 | -19 | -42 | -45 |
| 11 | Cars per capita | 22 | 22 | -20 | -2 | 3 | 11 | -38 |
| 12 | Emissions $CO_2$ per capita | -26 | -12 | -47 | -76 | 10 | 26 | -18 |

Source: ibid.

These two tables show the summary results of the development gap between Slovenia, EU15 average, Austria, Ireland, Finland, Spain, Portugal in Greece in two dimensions: by time distance and by percentage difference in a given moment. For the selected 12 indicators the largest differences with the average of EU15 occur in the indicators GDP per capita (purchasing power parity) and GDP per employee. Thus the basic problem of approaching the EU15 is to increase the productivity of the Slovenian economy. The catching up will not be simple. If the growth rates of GDP per capita would be two percentage points above EU average (for example scenario 5 percent and 3 percent) Slovenia would need 16 years for full equalization with the EU15 average. The best performance in the past was that of Ireland, which for about the same percentage gap in this indicator needed about 6 years time to reach the average of EU15. However, Ireland has at least three times higher exports per capita than Slovenia and in this indicator it leads Slovenia for at least ten years at Irish export growth

rates. It is clear that if Slovenia does not succeed to change the conditions for the achievement of development consensus and at the same time substantially improve the group of indicators concerning government, internationalization and finance, Slovenia would not be able to repeat the Irish experience in the approaching or catching up with the EU15 average.

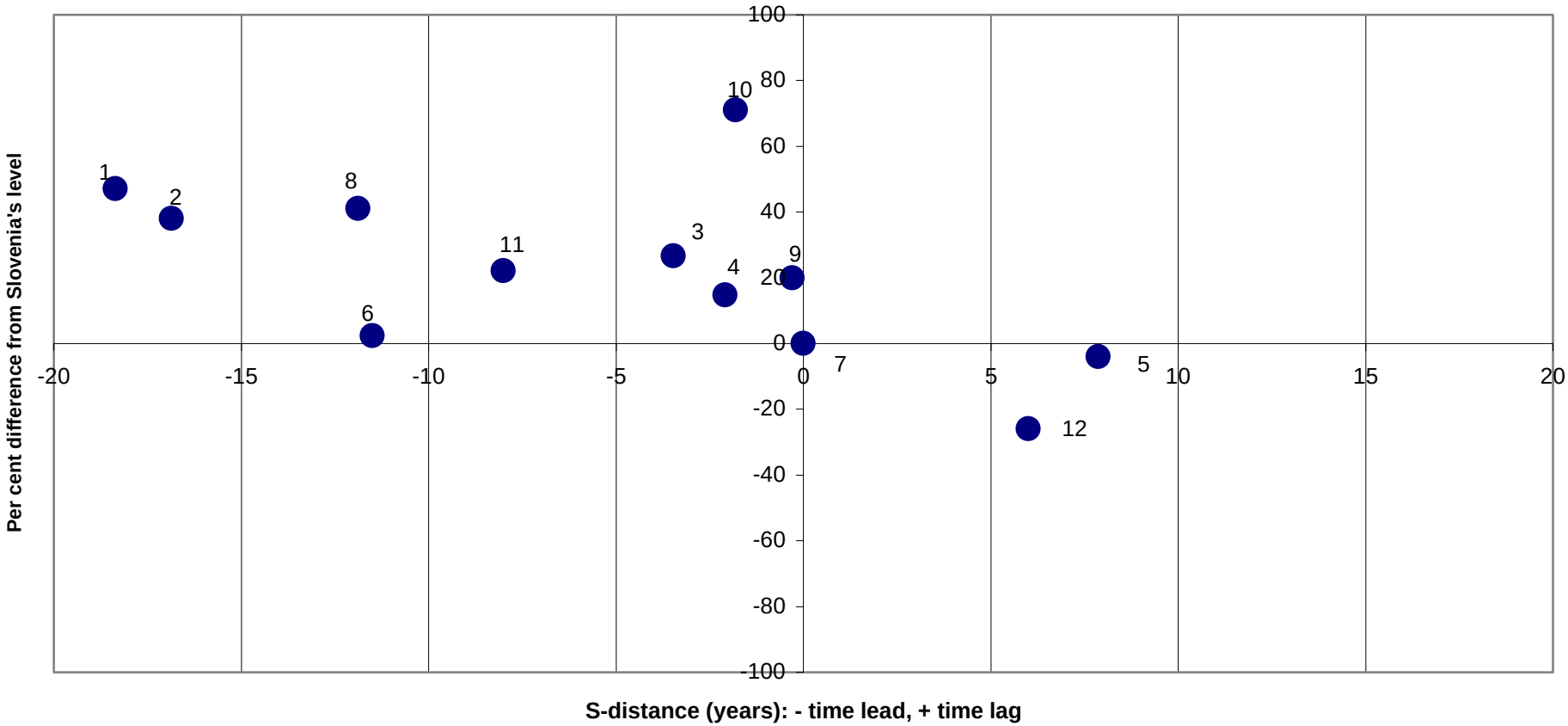
With respect to human resources Slovenia is lagging behind the EU15 average. It is necessary in the first place to increase the level of education and to prepare all generations for lifetime learning and fast changes in the working conditions and activity, to ensure the changes in the mentality and to prepare conditions for much more dynamic and flexible way of work activity. In spite of the stagnation of population, Slovenia has a higher share of total population in the age group 15-64, while at the same time this potential is both quantitatively and qualitatively used less efficiently as EU15 average. The analysis of indicators by time distance revealed another important conclusion: life expectancy of females, and particularly males, lags more than one decade behind the EU15; while the infant mortality in Slovenia is at the EU average. The indicator of life expectancy is an excellent example of the previous indication that the degree of disparities may be very different in static terms and in time. For life expectancy (female) the percentage difference between EU15 and Slovenia is only 2 per cent, which gives a false impression that the gap in this domain is negligible. The time distance of 12 years gives a completely different perception of the gap in this domain and leads to a qualitatively different policy conclusion.

In the field of telecommunications and information infrastructure in all three indicators Slovenia lags behind the EU15 average and also behind the six explicitly compared individual EU countries; the exception are Internet hosts where Slovenia is ahead of Spain, Portugal and Greece. The basic problem is, of course, the purpose and contents of the use of this infrastructure but we have to be aware of the fact that, in spite of the very high rates of growth, Slovenia is still lagging in these areas. However, the time distances are small because of the high dynamics of this phenomenon. This is in sharp contrast with the conclusion with respect to life expectancy. In the case of very fast growing phenomena like Internet hosts per capita or mobile phones per capita the time distances are small while the percentage differences are quite substantial. The maximum difference in time distance for EU countries and candidate countries from Slovenia is less than 5 years in either direction. In the area of environmental pollution Slovenia as a less developed country is better off concerning the emissions of $CO_2$ per capita relative to the EU15 average, while at the same time it is in a worse position concerning the emissions per unit of GDP and in terms of energy intensity.

Comparing time distances between Slovenia and EU15 average around 1998 across the 12 selected indicators shows that for 5 indicators the time lead of EU15 is about 10 or more years, for 5 other indicators the time lead of EU15 is 3 or less years, and for 2 indicators Slovenia is ahead of EU15. Figure 5 is an example of the two-dimensional presentation of disparities and in this case shows disparities between EU15 and Slovenia for selected indicators, simultaneously for static differences and for time distances. Here it is again possible to observe that the degree of disparities may be very different in static terms and in time. The two extremes are Internet hosts per capita, where the static difference is 71 per cent and time distance about 2 years, and life expectancy (female) with static difference of 2 per cent and time distance of 12 years. Such a graph allows visualization of many elements in a single graph. Between the two compared units (here EU15 and Slovenia) information on two dimensions of disparity (static disparity and time distance) are presented for a number of indicators and the ray between a single point and the center of the graph (0,0) provides an

**Figure 5**.

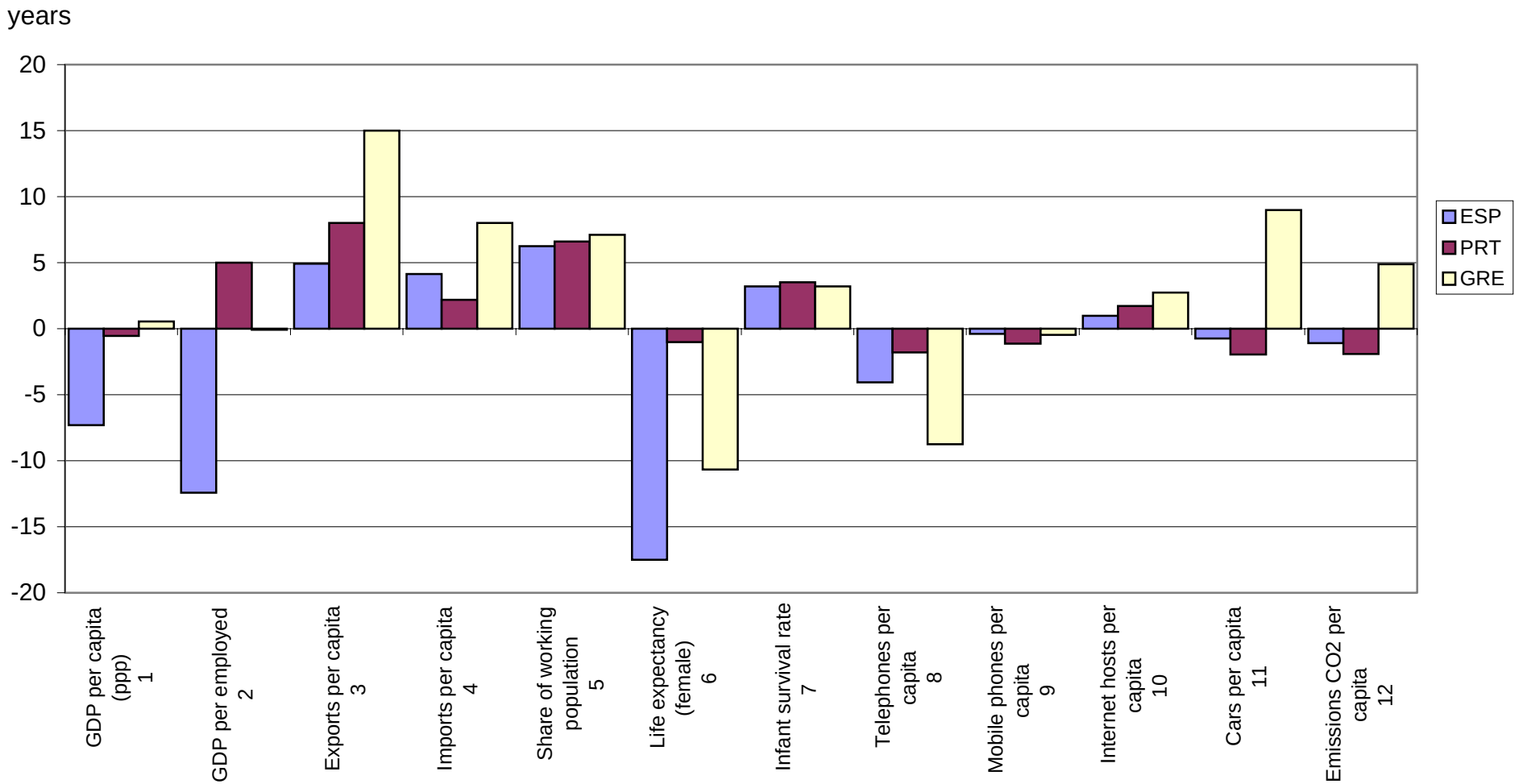
**Static difference and time distance between EU15 and Slovenia for selected indicators around 1998 (Slovenia=0)**




1. GDP per capita 2. GDP per employed 3. Export per capita 4. Import per capita 5. Share of working population 6. Life expectancy (female) 7. Infant survival rate 8. Telephones per capita 9. Mobile phones per capita 10. Internet hosts per 10000 inhabitants 11. Cars per capita 12. Emissions CO2 per capita

**Figure 6.**

**Time distance from Slovenia for Spain, Portugal and Greece for around 1998 in years**
**(Slovenia=0: positive value advantage of Slovenia, negative values advantage against Slovenia)**



additional indication of the growth rate of the phenomenon under scrutiny. At the same time comparison of these elements across all selected indicators is provided. Another important conclusion is that the difference between Slovenia and the EU15 is in general considerably smaller for other selected indicators than for the most frequently used GDP per capita.

Furthermore, comparison between Slovenia and Spain, Portugal and Greece across 12 selected indicators shows that Slovenia for the 12 selected indicators does not differ significantly from these countries. Looking at time distances, for approximately the same number of cases Slovenia has an advantage in comparison with these countries, or is lagging behind, respectively (see Figure 6). Only for three cases Slovenia lags behind one of these countries for more than ten years: 18 years behind Spain and 11 years behind Greece in female life expectancy and 12 years behind GDP per employee for Spain. Also, if we look at the percentage difference around 1998 the conclusion does not change. The only two cases out of the 12 indicators for the three countries, where the value of the indicator is 40 percent greater from the value for Slovenia, are the number of mobile phones per capita for Portugal and the number of stationary phones per capita in Greece. As mentioned before, on the basis of selected hard indicators Slovenia undoubtedly belongs to this group of three EU countries.

## 5. Comparing selected EU and candidate countries

Section 5 differs from the previous section in two respects. First, in Section 4 the base unit of comparison was Slovenia and the respective static and time distances for EU15 and selected EU countries where calculated from the values for Slovenia around 1998. In this section all values are calculated as distances from EU15 average, while the basis for comparison are the values for the three selected EU countries and five selected candidate countries around 1999. Second, these values are more recent estimates depending on the availability of data, which range from 1998 for life expectancy, infant survival rent and cars per capita to January 2001 for mobile phones per capita.

The point of this section is the broad conclusion about the possible difference in conclusions based on the static relative disparities and time distances across selected indicators for these countries rather than the precision of measuring disparities among these countries. Table 3 presents the magnitude of development gaps from EU15 as measured by time distance, on the one hand, and relative static disparities (EU15=100) in Table 4, on the other. Comparison of Table 5 with Table 6 shows, as in the case of Slovenia in Section 4, that the ranking of different fields of concern (indicators) by the magnitude of disparity with EU15 is quite different for both dimensions. Let us illustrate this conclusion with regard to the most important differences in conclusions based on the two dimensions of disparity.

Two very relevant synthetic indicators are GDP per capita (1) and life expectancy (female) (2). First, in Table 5 GDP per capita (1) is for most of the analysed countries ranked somewhere in the middle of the list of indicators, while time distances in Table 6 indicate that this is for candidate countries by far the largest time lag behind EU15, similar change of ranks appears for the three analysed EU countries. Second, percentage differences for life expectancy (4) between these countries and EU15 are very small, while time distances are very large, the two exceptions are Spain in Greece. Large reversal in ranking is observed also for mobile phones per capita (7) and Internet hosts per capita (8). Important conclusion follows: for a proper evaluation of the magnitude of disparity with EU15 and the resulting strategic policy decisions both dimensions should be taken into account simultaneously.

**Table 3. Magnitude of development gaps from EU15 as measured by time distance in years (EU15 average=0, - time lead, + time lag behind EU15)**

| No. | Indicator | ESP | PRT | GRE | SLO | CZE | HUN | SVK | POL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | GDP per capita (ppp) | 12 | 14 | 21 | 16 | 28 | 31 | 32 | 38 |
| 2 | Exports per capita | 16 | 20 | | 4 | 20 | 22 | | |
| 3 | Imports per capita | 11 | 10 | 14 | 2 | 15 | 20 | 21 | |
| 4 | Life expectancy (female) | -6 | 11 | 1 | 12 | 14 | 26 | 20 | 17 |
| 5 | Infant survival rate | 3 | 4 | 3 | 0 | 0 | 14 | 11 | 13 |
| 6 | Telephones per capita | 10 | 9 | 1 | 13 | 13 | 11 | 18 | |
| 7 | Mobile phones per capita | 0.1 | -0.1 | 0.2 | 0.3 | 0.8 | 1.6 | 1.9 | 2.5 |
| 8 | Internet hosts per capita | 3.2 | 4.6 | 3.5 | 3.4 | 2.4 | 3.6 | 4.4 | 3.9 |
| 9 | Cars per capita | 7 | 18 | 22 | 8 | 17 | 25 | 25 | 25 |

**Table 4. Static relative disparities with respect to the EU15 average around 1999 (EU15=100)**

| No. | Indicator | ESP | PRT | GRE | SLO | CZE | HUN | SVK | POL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | GDP per capita (ppp) | 81 | 74 | 68 | 72 | 58 | 52 | 48 | 39 |
| 2 | Exports per capita | 48 | 42 | 17 | 76 | 43 | 38 | 33 | 12 |
| 3 | Imports per capita | 60 | 66 | 50 | 88 | 49 | 44 | 42 | 21 |
| 4 | Life expectancy (female) | 102 | 98 | 100 | 97 | 97 | 93 | 95 | 96 |
| 5 | Infant survival rate | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 6 | Telephones per capita | 78 | 79 | 99 | 71 | 69 | 75 | 57 | 48 |
| 7 | Mobile phones per capita | 97 | 106 | 89 | 87 | 68 | 47 | 38 | 28 |
| 8 | Internet hosts per capita | 41 | 22 | 37 | 40 | 55 | 36 | 25 | 31 |
| 9 | Cars per capita | 90 | 71 | 56 | 88 | 79 | 48 | 49 | 51 |

**Table 5. Comparing static relative disparities across countries and indicators**

| EU15=100 | ESP | PRT | GRE | SLO | CZE | HUN | SVK | POL |
|---|---|---|---|---|---|---|---|---|
| 101-109 | 4 | 7 | | | | | | |
| 100 | 5 | 5 | 4,5 | 5 | 5 | 5 | 5 | 5 |
| 90-99 | 7,9 | 4 | 6 | 4 | 4 | 4 | 4 | 4 |
| 80-89 | 1 | | 7 | 3,7,9 | | | | |
| 70-79 | 6 | 1,6,9 | | 1,2,6 | 7,9 | 6 | | |
| 60-69 | 3 | 3 | 1 | | 6 | | | |
| 50-59 | | | 3,9 | | 1,8 | 1 | 6 | 9 |
| 40-49 | 2,8 | 2 | | 8 | 2,3 | 3,7,9 | 1,3,9 | 6 |
| 30-39 | | | 8 | | | 2,8 | 2,7 | 1,8 |
| 20-29 | | 8 | | | | | 8 | 3,7 |
| 10-19 | | | 2 | | | | | 2 |
| 0-9 | | | | | | | | |

Source: Table 4; the numbers in this table represent indicator names from Table 4.

**Table 6. Comparing time distances from EU15 across countries and indicators (S-distance in years, EU15=0, + time lag behind EU15, - time lead ahead of EU15)**

| Years | ESP | PRT | GRE | SLO | CZE | HUN | SVK | POL |
|---|---|---|---|---|---|---|---|---|
| -10 | | | | | | | | |
| -9 | | | | | | | | |
| -8 | | | | | | | | |
| -7 | | | | | | | | |
| -6 | **4** | | | | | | | |
| -5 | | | | | | | | |
| -4 | | | | | | | | |
| -3 | | | | | | | | |
| -2 | | | | | | | | |
| -1 | | 7 | | | | | | |
| 0 | 7 | | 7 | 5,7 | 5,7 | | | |
| 1 | | | **4**,6 | | | 7 | 7 | |
| 2 | | | | 3 | 8 | | | 7 |
| 3 | 5,8 | | 5,8 | 8 | | 8 | | 8 |
| 4 | | 5,8 | | 2 | | | 8 | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | 9 | | | | | | | |
| 8 | | | | 9 | | | | |
| 9 | | 6 | | | | | | |
| 10 | 6 | 3 | | | | | | |
| 11 | 3 | **4** | | | | 6 | 5 | |
| 12 | **1** | | | **4** | | | | |
| 13 | | | | 6 | 6 | | | 5 |
| 14 | | **1** | 3 | | **4** | 5 | | |
| 15 | | | | | 3 | | | |
| 16 | 2 | | | **1** | | | | |
| 17 | | | | | 9 | | | **4** |
| 18 | | 9 | | | | | | |
| 19 | | | | | | | | |
| 20 | | 2 | | | 2 | 3 | **4** | |
| 21 | | | **1** | | | | 3 | |
| 22 | | | 9 | | | 2 | | |
| 23 | | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | 9 | 9 | 9 |
| 26 | | | | | | **4** | | |
| 27 | | | | | | | | |
| 28 | | | | | **1** | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| 31 | | | | | | **1** | | |
| 32 | | | | | | | **1** | |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | **1** |

Source: Table 3; the numbers in this table represent indicator names from Table 3. The respective time distance describes how many years earlier was the value of a given indicator around 1999 reached by EU15 average.

## 6. Growth rate effects and broader concept of convergence

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.

The empirical sections of this paper illustrate the position that definitions of two concept, degree of inequality and convergence, have to be broadened by the concept of time distance to incorporate the time dimension of disparity. In Table 7 and Figure 7 the empirical example is presented of how the conclusions about the convergence can change significantly, if one is using only relative static measures like ratios, percentages, Gini coefficient or Theil index or if both static dimension and time distance are taking into account simultaneously. The more general case of convergence viewed in two dimensions, in time and in indicator space, is presented in Table 8.

Table 8 shows 9 different combinations of a static measure of disparity and time distance. In this table ratio of the levels of the analysed indicator (like values in Table 4) is used as a possible choice of static measures of disparity. However, other static measures of disparity could be used also in this classification in line with the preference of the researcher or policy maker. One can find in Table 8 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 proximity is increasing 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.

In Table 7 an empirical case is presented for GDP per capita based on data from Maddison (2001). One of the distinct characteristics of postwar development in the world is a significantly higher growth rate of GDP until 1973. For the base country of comparison we have selected France and the respective time distances and percentage differences for 1966, 1973 and 1998 for USA, Spain, Portugal and Greece were calculated.

**Table 7. GDP per capita, different conclusions about convergence based on static relative disparity and time distance, periods of high growth rate before 1973 and slower growth rate after 1973**

| | Time distance from France | | | | Percentage difference from France | | | |
|---|---|---|---|---|---|---|---|---|
| | USA | Spain | Portugal | Greece | USA | Spain | Portugal | Greece |
| 1966 | -16 | 15 | 22 | 18 | 45 | -43 | -52 | -50 |
| 1973 | -8 | 10 | 13 | 13 | 27 | -33 | -44 | -42 |
| 1998 | -14 | 21 | 25 | 29 | 40 | -27 | -34 | -42 |

Source: Own calculation based on data from Maddison (2001), for Portugal and Greece 1968 instead of 1966.

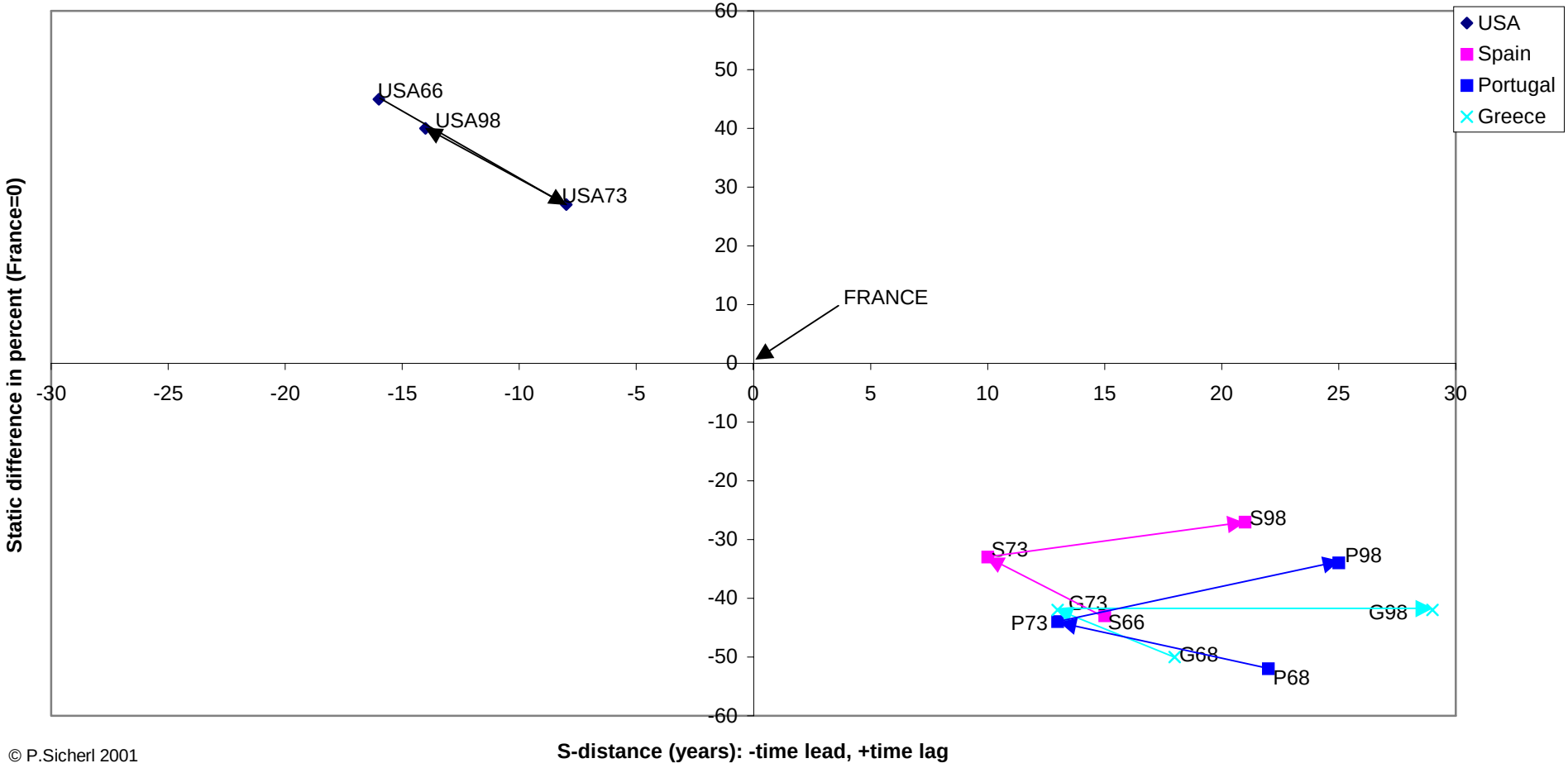
For the observed developments until 1973 the qualitative conclusions about the convergence based on static relative disparity and time distance are similar, both time distances and percentage differences from France were decreasing. This means that all four cases would belong to field 9 in Table 8. In Figure 7 this can be observed that all points for these countries were in 1973 closer to the France, which is shown as the point (0,0) in the coordinate system in the figure, than in the previous years shown.

The change from 1973 to 1998 is a different story. USA again improved its position in GDP per capita with France in both dimensions; the percentage difference was now 40 percent and time lead 14 years. The qualitative conclusion about convergence or divergence was the same in both dimensions; the case belongs to field 1. However, for the three compared EU countries the conclusions about convergence or divergence are qualitatively different for the static dimension and the time dimension of disparity. Spain and Portugal further decreased the percentage difference with France, while for Greece the percentage difference remained unchanged. The change in time distance shows a very different picture: in the period 1973-1998 the time distance with France increased for Spain from 10 to 21 years, for Portugal from 13 to 25 years, and for Greece from 13 to 29 years. This is not a result of a situation that GDP per capita for these three countries would be growing slower than that of France. On the contrary Spain and Portugal were growing faster, otherwise the percentage differences would not be decreasing. The cases of Spain and Portugal belong to field 7 and the case of Greece in field 4 of Table 8. As explained at the beginning of this section, the increase of time distances for these three countries in comparison to France in the last 25 years is the consequence of the fact that the absolute value of growth rate of GDP per capita was in the period 1973-1998 lower than in the period before 1973. In a dynamic framework where both differences between growth rates and absolute magnitude of the growth rates are taken into account, a broader concept of the convergence might deliver important new conclusions, which cannot be reached without this broader theoretical and analytical framework.

**Table 8. 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*<br>Ratio ↑<br>S-distance ↑ | *4*<br>Ratio =<br>S-distance ↑ | *7*<br>Ratio ↓<br>S-distance ↑ |
| | *2*<br>Ratio ↑<br>S-distance = | *5*<br>Ratio =<br>S-distance = | *8*<br>Ratio ↓<br>S-distance = |
| | *3*<br>Ratio ↑<br>S-distance ↓ | *6*<br>Ratio =<br>S-distance ↓ | *9*<br>Ratio ↓<br>S-distance ↓ |

**Figure 7. Time and percentage distances for USA, Spain, Portugal and Greece from France: GDP per capita, own calculation based on data from Maddison 2001 (constant 1990 $)**



## 7. Conclusions

The first important conclusion of this paper is methodological. To deal effectively with the new opportunities and threats under conditions of accelerated change and continuous learning we need both adequate changes in the strategies at various levels and their integration, on the one hand, and appropriate adjustments in the state-of-the-art of socio-economic analysis in line with the new circumstances, on the other. This paper presents an illustration of one of such improvements. It shows that the conventional analysis of disparities should be complemented by the time distance concept and measure to ensure a more comprehensive vision of the situation for analysis and policy decisions in a dynamic context. The novel time distance methodology provides new insight to the problems, an additional statistical measure, and a presentation tool for policy analysis and debate expressed in time units, readily understood by policy makers, media and general public.

In its role as a descriptive statistical measure, complementing existing approaches, time distance can be applied literally to thousands of cases of time series comparisons so that additional information content embodied in countless databases in different fields of concern for socio-economic research is not left unutilized. In addition to the use of S-distance as a descriptive statistical measure, the broader conceptual framework poses new interesting questions for growth and welfare theory, and the related policy issues. It relates performance and efficiency in a novel way to the broader notion of the overall degree of disparity. If one does not use explicitly the broader framework outlined here, there is a possibility that in political debate and policy formulation various interest groups would intentionally look only at the specific statistical measure that will suit their particular interest.

Especially in dealing with a wider set of fields of concern and a greater number of indicators the additional view of the problem provided might be important for a more realistic evaluation of the situation, for improved semantics of discussing the policy issues, and for monitoring of progress. By analogy this methodology could be applied to numerous similar problems in business at the micro and corporate levels. This methodology can be usefully applied also to benchmarking, target setting and monitoring of progress for a large number of indicators in many areas of concern, either for long-term, medium-term or short-term analysis.

The second important conclusion refers to the application of this methodology to a particular example where this methodology was applied to the evaluation of the degree of the disparity between Slovenia and the European Union in Section 4 and between selected EU and candidate countries in Section 5. It was confirmed that the degree of disparities might be very different in static terms and in time, some indicators showed small disparity in percentage terms and large disparity in terms of time distance, and vice versa. The ranking of indicators by the degree of disparity between selected EU and candidate countries from EU15 average by the static measure and time distance was quite different. This indicates that for a more realistic perception of the disparities and for strategic policy decisions the present predominantly static methodological framework has to be broadened by the time distance dimension. Similarly, the concept of convergence and divergence has to be viewed in two dimensions: proximity in time and proximity in the indicator space. The example of Spain and Portugal, which in the period 1973-1998 decreased their percentage difference in GDP per capita with France but increased their lag in time, brings important lesson for dealing with convergence in the EU. Furthermore, the visualization of the time distance results confirmed the proposition that time distance comparisons can serve as an important analytical, presentational and communication tool for many purposes and across many fields of concern.

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