e-Business W@tch
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Special Issue Study No. A

A User's Guide to ICT Indicators:

Definitions, sources, data collection and challenges involved

Including Pilot Studies on

a) e-Commerce S-Time-Distance Statistics

b) The Use of Correspondence Analysis for Country Comparisons

Revised Report

June 2005

European Commission
Enterprise & Industry Directorate General
Technology for Innovation / ICT Industries and e-Business

The *e-Business W@tch*

The European Commission, Enterprise & Industry Directorate General, launched the *e-Business W@tch* to monitor the growing maturity of electronic business across different sectors of the economy in the enlarged European Union, EEA and Accession countries. Since January 2002 the *e-Business W@tch* has analysed e-business developments and impacts in manufacturing, financial and service sectors. Results are being published on the Internet and can be accessed or ordered via the Europa server or directly at the *e Business W@tch* website (www.europa.eu.int/comm/enterprise/ict/policy/watch/index.htm or www.ebusiness-watch.org).

This report is a Special Issue Study on ICT Indicators. It provides an overview of the state-of-play in developing adequate indicators for measuring e-business developments, on methods to collect the relevant data, and on challenges involved in this activity. The report is intended as a handbook for users of ICT indicators.

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Executive Summary

Constructing meaningful ICT indicators – a challenge for statistics

The fast adoption of information and communication technologies in business, and the objective to anticipate possible policy implications of this development, has triggered a demand for statistical information on the diffusion of ICT in firms and about related activities. ICT indicators can be grouped in many ways, but a basic distinction can be made between four broad areas of measurement:

- **Statistics on the ICT sector**: measurement of the contribution of the ICT sector to the overall economy. This report makes references to OECD work in this area, and features EITO European Information Technology Observatory as one of the most important and authoritative source for ICT market statistics in Europe.
- **Statistics on ICT investment**: Measurement of the aggregate investments by firms on ICT, and data on household spending on ICT. Statistics are closely related to ICT sector statistics, but take a demand-side perspective, focusing on buyers' expenditures and behaviour.
- **Statistics on ICT use**: indicators focusing on the adoption and use of ICT in firms and households. Indicators are mostly derived from representative surveys. The e-Business Survey by *e-Business W@tch* and the annual Survey on ICT Use in Enterprises by Eurostat are relevant examples in Europe.
- **ICT service indicators**: measurement of the availability, price and quality of ICT services, particularly telecommunication services. These are supply-side indicators, provided, for instance, by ITU (International Telecommunications Union) and by the OECD.

This study focuses on the third category. It discusses issues related to the definition of indicators on ICT use and presents challenges that are related to the corresponding data collection. Major challenges in this context are definition issues (what exactly constitutes "e-business" and should be measured?), the adequate translation of concepts into survey questions, and issues of adequate aggregation methods (e.g., weighting of results). The report addresses mainly policy makers who occasionally work with ICT statistics, rather than ICT experts themselves. It does not address statisticians, as they are fully familiar with the issues presented in this report.

What users of ICT survey results should know

In many cases, confusion about statistical data is the result of misunderstandings, either because of unclear meta-information about the data, or because of misguided expectations on the side of the user. Users of ICT indicators should ideally possess a basic understanding of key issues and processes of data collection. Four concepts are key to a proper reading of data stemming from surveys:

- The **universe** of the survey: What types of companies or organizations were included in the survey?
- The **base** of a figure: If a value is 28%, what exactly does "100%" stand for?
- The **weighting** scheme: Do small and large enterprises count equally in percentages, or have data been weighted by employment?
- The statistical **confidence interval**: What is the statistical accuracy that can be expected from the data presented?

The role of research projects vis-à-vis official statistics

The main strength of indicator related research projects is their flexibility in developing and piloting new approaches, without being bound by the "legacy" of existing statistics. The down-side is hat these efforts are mostly one-off studies, and that they usually do not have the resources to collect primary data on a substantial level. Ideally, therefore, the successful parts of these pilot exercises should migrate into the regular surveys carried out by official statistics. This report features selected research projects, mainly from the R&D Framework Programmes of the EU that have addressed the issue of information society and economy indicators.

Compound indicators and recommendations for users

Notwithstanding the risks and limitations of compound indicators, the report encourages policy makers to actively promote the development of compound indicators and to make use of them. There are many good examples of the usefulness of compound indicators, particularly in policy areas which do not lend themselves to be measured by one or two specific indicators only. Moreover, compound indicators are a powerful instrument to trigger public debate about policy objectives, which can be a desirable goal in itself in terms of fostering democracy.

Innovative approaches in indicator development

The study features two methodological approaches for adding value to simple indicators that could be particularly useful for policy: S-time-distances, and correspondence analysis.

- The new generic time distance approach (with the statistical measure "**S-time-distance**") offers a new view of data that is easy to understand and communicate: it shows differences in adoption rates (e.g. of technology) as differences in time when a given rate was attained by laggards and by the benchmark adopter. This method can be applied to e-business adoption. For instance, the relative disparity in the adoption of online buying activity between the UK and Spain (adoption rates 46% and 19%, respectively, in 2003) can be translated into an S-time-distance of about 3 years.
- **Correspondence analysis** (CA) can be considered as an alternative approach to compound indicators. CA is a descriptive, multivariate method that can handle small and large data-sets to produce a graphical output of the results. CA can reveal underlying structures in a large data set by reducing its complexity, without loosing essential information. It is methodologically related to principal components / factor analysis.

Policy recommendations

Policy is not only an important user of statistics on ICT diffusion and impacts, but is also in charge of making the necessary provisions that these statistics are available in high quality. The report makes the following recommendations for adequate use of statistics and for establishing mechanisms to further improve the quality of indicators:

Policy objective	Suggestions for policy
Provision of adequate indicators on ICT adoption	• Strengthen links between activities of official statistics and research projects • Strengthen links between closely related regular surveys carried out by official statistics • Carry on efforts to develop meaningful compound indicators for the information society and economy
Good use of existing ICT indicators in policy making processes	• Use compound indicators as a vehicle to trigger public debate • Going beyond GDP: Apply the Balanced Scorecard technique for monitoring EU information society and economy development

Part II: Pilot Studies – Adding Value to ICT Indicators

5 Sectoral time-distances in the adoption of e-commerce activity[1]

5.1 S-time-distances: concept and definition

Time, besides money, is one of the most important reference frameworks in a modern society. Yet the present methods of analysis and statistics do not fully utilise the information embodied in the existing data that could contribute to a better understanding of the situation.

The art of handling different views of data is crucial for discovering the relevant patterns and for providing a broader framework for policy analysis. The new generic time distance approach (with associated novel statistical measure S-time-distance) offers a new view of data that is exceptionally easy to understand and communicate, and it allows for looking at the situation in an additional way and exploring new perspectives.

Time distance analysis requires a radical shift in perspective with respect to time series data. Under the perspective dominating in the literature, comparisons and evaluation of disparities (gaps) are made on the basis of absolute or relative values of a given 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 characterised as 'temporal', has its main focus on the horizontal differences in time for each level of analysed 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 indicator.

Time distance in general means the difference in time when two events occurred. So the concept and the term time distance are used in many fields and applications. For instance, in spatial analysis time distance may mean the time needed to come from one point to another point in space. In our use of time distance as a measure of difference (disparity or proximity), we define a special category of time distance, which is related to the level of the analysed indicator.

The suggested statistical measure S-time-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.) for given levels of the indicator is used as a temporal measure of disparity between the two series, in the same way that the observed difference (absolute or relative) at a given point in time is used as a static measure of disparity. It is remarkable that the this specific notion of time distance, which can be in principle developed from the same information embodied in the existing data, has not been developed earlier as a standard statistical measure.

For a given level of the indicator X_L, $X_L = X_i(t_i) = X_j(t_j)$, S-time-distance is the time difference between points in time when unit (i) and unit (j) reached 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, T_2 ...T_n).

[1] This pilot study was contributed by Prof. Pavle Sicherl, Founder and Head of SICENTER (Socio-economic Indicators Center) and Professor of Political Economy at the University of Ljubljana.

This special category of time distance is a generic concept like relative disparity or growth rate (for more details consult Sicherl, e.g. 1973, 1994, 1997, 1999, 2004a, 2004b, 2004c and 2004d, on which this section is based).

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. A new dimension is added while no earlier results are lost or replaced.

The time perspective, which no doubt exists in human perception when comparing different situations, is thus systematically introduced both as a concept and as a quantifiable measure in statistical and comparative analysis. Expressed in time units it is an excellent presentation tool easily understood by policy makers, managers, media and general public and can support decision-making and influence public opinion.

From the numerical examples, based on *e-Business W@tch* data from the e-Business Survey 2003, a comparison of percentage of enterprises buying and selling online for all sectors will be first used as a thorough methodological explanation of the methodology used in this chapter. Exhibit 5-1 and Exhibit 5-3 show the respective percentages from the survey. Exhibit 5-1 shows also the yearly growth rates of the variable. Obviously the yearly growth of percentages of enterprises buying and selling online is exceptionally high, one deals with a very dynamic process. This characteristic has also important consequences for analysing the differences between developments in different sectors. The evaluation may be very different if based on static measures of differences or on time distances.

In comparative analysis a better integration of comparisons across time and space is needed. In the dynamic world of today it is hardly satisfactory to rely only on static measures of disparity. Among other problems, the static statistical measures of disparities like ratios or percentage differences (or Gini coefficient, Theil index or coefficient of variation for the case of many units) are insensitive to the changes in the absolute magnitude of growth rates of the indicator (or differences in growth rates among different indicators) and take into account only differences in growth rates between the units. They have to be supplemented by Sicherl time distance to incorporate the temporal relative position of a given unit against the benchmark as an essential element of analysis (SIBIS 2003, p. 211).

Exhibit 5-1: Diffusion of e-commerce activity in percentage of enterprises for all sectors

	Percentage		Yearly growth rate (in %)	
Time	**Buying online**	**Selling online**	**Buying online**	**Selling online**
1995	0.9	0.3		
1996	1.4	0.3	52	2
1997	1.9	0.4	38	18
1998	3.5	0.7	87	64
1999	6.6	1.6	88	136
2000	10.8	2.5	62	55
2001	16.8	4.9	57	102
2002	24.1	6.6	43	34
2003	30.3	9.0	26	36

Source: SICENTER / *e-Business W@tch* (2005)

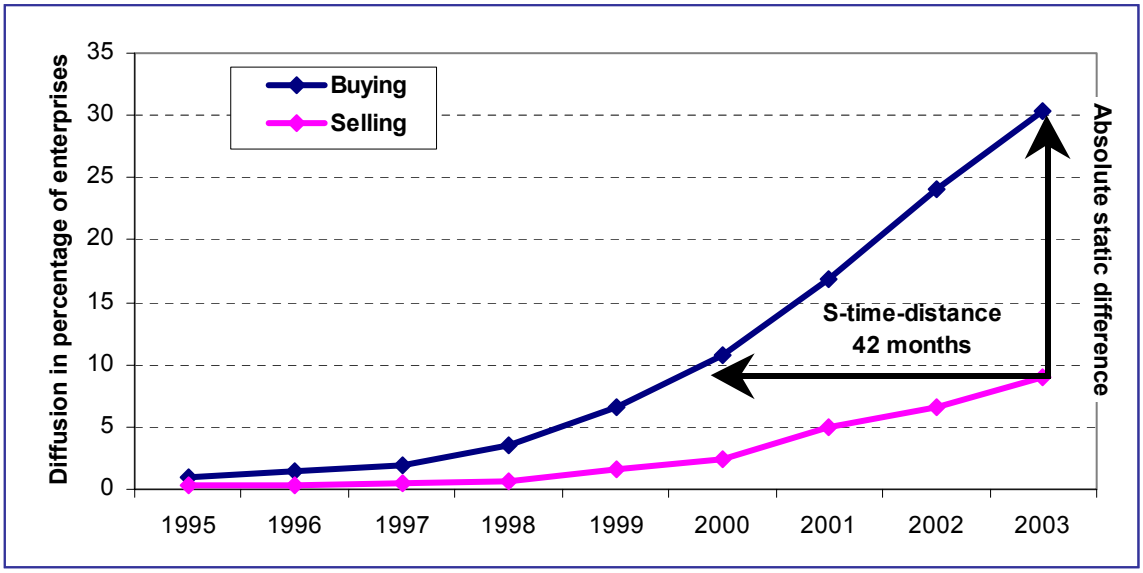
Exhibit 5-2: Various measures of difference between buying and selling online for all sectors

Time	Absolute difference (buying-selling)	Relative measure (index selling=100)	S-time-distance: - time lead for buying (selling=0)	
			in months	in years
1995	0.6	268		
1996	1.0	398		
1997	1.5	463		
1998	2.9	527		
1999	5.1	419	-32	-2.6
2000	8.3	439	-32	-2.7
2001	11.9	341	-31	-2.6
2002	17.5	365	-37	-3.0
2003	21.3	338	-42	-3.4

Source: SICENTER / *e-Business W@tch* (2005)

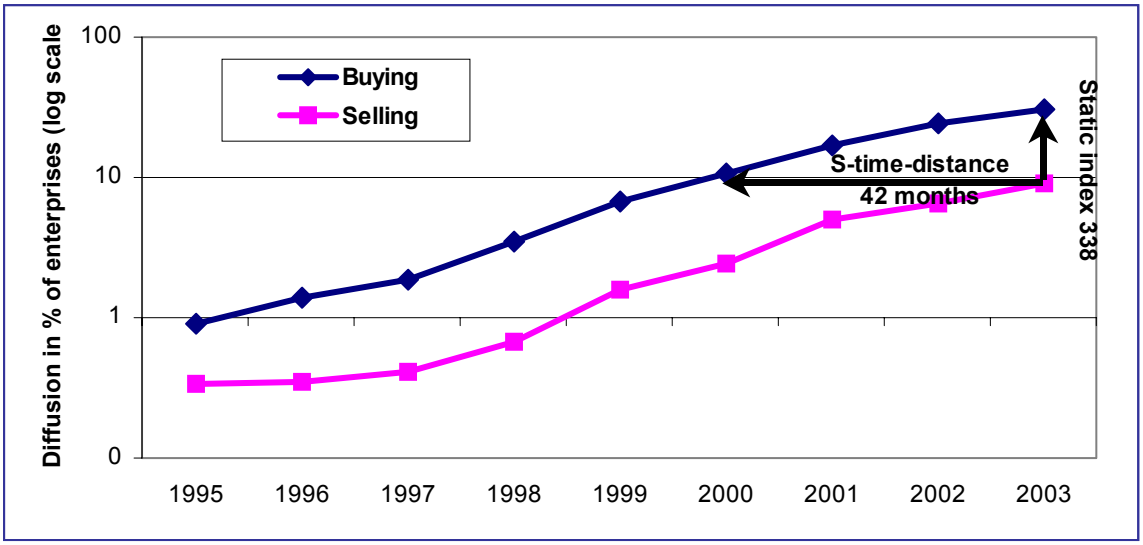
Exhibit 5-2 provides various measures of difference between buying and selling online for all sectors for the analysed period. The first two columns are the standard static measures of difference at the respective points in time. Absolute difference between the percentages of enterprises buying online and those selling online is increasing throughout the period.

Exhibit 5-3: Diffusion of online buying and online selling among firms for all sectors (1995-2003)



Source: SICENTER / *e-Business W@tch* (2005)

Exhibit 5-4: Diffusion of online buying and online selling among firms for all sectors (1995-2003) – relative measures



Source: SICENTER / *e-Business W@tch* (2005)

The relative differences, expressed as index of the percentage selling online, are very high; at the peak in 1998 the percentage of enterprises buying online was more than 5 times higher, even in 2003 the index still stands at a very high value of 338. We shall now add an additional perspective to the situation by expressing the differences between buying and selling online in terms of time distance measure.

Exhibit 5-3 and Exhibit 5-4 provide a visualization of the novel concept encompassing time distance measure as a missing element for a broader framework of measuring differences (proximity) in two dimensions. The overall degree of disparity is conceived as a combination of two measures of differences between the two compared time series, one in vertical dimension and one in horizontal dimension. They are, in the respective exhibits, represented by two arrows.

The vertical dimension of the gap relates to static measures of difference in the indicator/variable values, expressed either as the absolute difference (in original units of the indicator/variable) or as relative difference (in unnamed units like index or percentage difference). The horizontal dimension of the gap relates to the time dimension of the gap for a given level of the indicator and S-time-distance is expressed in standardized easily understood time units. It is the combination of three measures, static difference(s), time distance and the growth rate(s) which should be used simultaneously to better describe the complexity of the situation.[2]

Exhibit 5-3 and Exhibit 5-4 show an important characteristic of the S-time-distance concept and measure. When combined with other methods, earlier results are left unchanged, but new conclusions may be reached due to an added dimension of analysis. In practical use this is very helpful. All results of the other methods usually used in such analysis are not to

[2] See e.g. Sicherl (1999) for providing evidence that the S-time-distance measure is a generic statistical measure like static measures of disparity or growth rates. Here S-time-distance is used as one of the measures of the gap in adoption of e-commerce activity. However, as a novel generic statistical measure it can be used in many other applications. For ideas and examples of 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), for variables other than time Sicherl (1999). Granger and Jeon (1997, 2003) further elaborated S-time-distance for the use as a criterion for evaluating forecasting models of leading and lagging indicators.

be replaced or substituted but rather complemented by a novel perspective. This by definition means that more information is available to create a perception of the situation. In other words, one cannot be worse off by having another perspective and in many cases this would be very helpful and may change the overall conclusions.

In the Exhibit 5-3 the visualization of the two dimensions is shown by the two arrows for the level of percentage diffusion of enterprise for online selling in the year 2003. This percentage 9% is than compared in the two dimensions with the time series of diffusion of online buying. In the vertical dimension the absolute static difference in March 2003 amounts to 21.3% (30.3% - 9.0%). When we compare in the horizontal dimension, we search in time series for online buying when the same percentage of 9% of online selling was achieved in the past for online buying. This was achieved in October 1999, which means that the S-time-distance amounts to 42 months. In other words, the percentage of enterprises that were active in online selling in March 2003 was active in online buying 42 months or 3.4 years earlier.

Exhibit 5-4 is showing the same data on the diffusion of online buying and online selling for all sectors as Exhibit 5-3, but using logarithmic scale. Graphically this means in general two things. First, equal vertical distances between two time series mean equal relative differences between the compared time series at a given point in time. Second, equal slopes of the lines mean equal growth rates.

Various measures of difference between buying and selling for all sectors are presented in Exhibit 5-2. In addition to the results of the two static measures in the first two columns, the corresponding estimates of S-time-distance are presented in the last two columns (expressed either in months or in years). It is interesting to note that the S-time-distance of 42 months is shown in both figures for the respective level, no matter that the static difference is once expressed in absolute differences and in the second case as static index or percentage difference. The development over time of differences between buying online and selling online shown in Exhibit 5-1 and Exhibit 5-2 demonstrate different conclusions. Absolute differences between buying and selling online is increasing over time, relative measure is decreasing from the peak from 1998, yearly rate of growth for both series is falling in the last years and so the S-time-distance is slightly increasing.

As analysed in The European e-Business Report, 2004 edition (European Commission 2004) in detail, the buying online is much more prevailing than selling online. Already in this analysis for all sectors it has been shown that because of the very high growth rate of the increase of both online buying and online selling the very large gap between the two at a given point in time has resulted in a time lag of less than 3 and a half years at most. In other words, the analysis of S-time-distance in combination with other measures shows (see e.g. Exhibit 5-2) that the main reason for the difference lies in the fact that diffusion of online selling was starting later, as already in 1999 the time distance was 32 months. From that period on the rate of growth of online selling was even higher than for online purchasing. The higher rate of growth of online selling as compared with purchasing online in the second part of the period resulted in a decline of the relative static gap but in a slight increase in S-time-distance due to lowering of the yearly growth rates of both online selling and online buying as the higher percentage of enterprises are being reached.

5.2 Online buying activity

Using the time distance methodology explained in the section above and data from the e-Business Survey 2003 (cf. European Commission 2004) we are examining the time distance gap between 10 analysed sectors in the above mentioned report. The benchmark used in these comparisons is the percentage of enterprises buying online for all sectors. The numerical values for the benchmark were presented in Exhibit 5-1.

The results for S-time-distance calculation are presented in Exhibit 5-5. E.g. for those sectors, which experienced a higher value of the percentage of enterprises buying online than the corresponding value for all sectors, this fact also generally means that the same value was achieved earlier in time than the average for all sectors. Thus subtracting the time when the specified level of the indicator was reached by the respective sector and by the average for all sectors gives the value of the S-time-distance for that level of the indicator. Negative values of S-time-distances for a given sector mean time lead for that sector in comparison with the average value for all sectors (positive values mean time lag) for the selected level of the indicator.

Exhibit 5-5: S-time-distances in months for buying online for sectors compared with the average percentage of diffusion for all sectors (- time lead, + time lag for the respective sector, average=0)

Sector/Time	1996	1997	1998	1999	2000	2001	2002	2003
ICT services			-33	-37	-33	-35	-42	-50
Electronics			-14	-10	-14	-18	-22	-29
Tourism			-17	3	-1	-5	-8	-12
Business services			-1	-5	-5	-4	-3	-5
Chemical			11	8	7	1	-3	-3
All sectors	0	0	0	0	0	0	0	0
Transport	6	-2	8	6	3	1	-1	1
Retail		19	10	16	9	11	10	13
Health		1	12	17	20	16	16	21
Craft' & trade			37	24	22	21	19	20
Textile				14	18	24	23	32

Source: SICENTER / *e-Business W@tch* (2005)

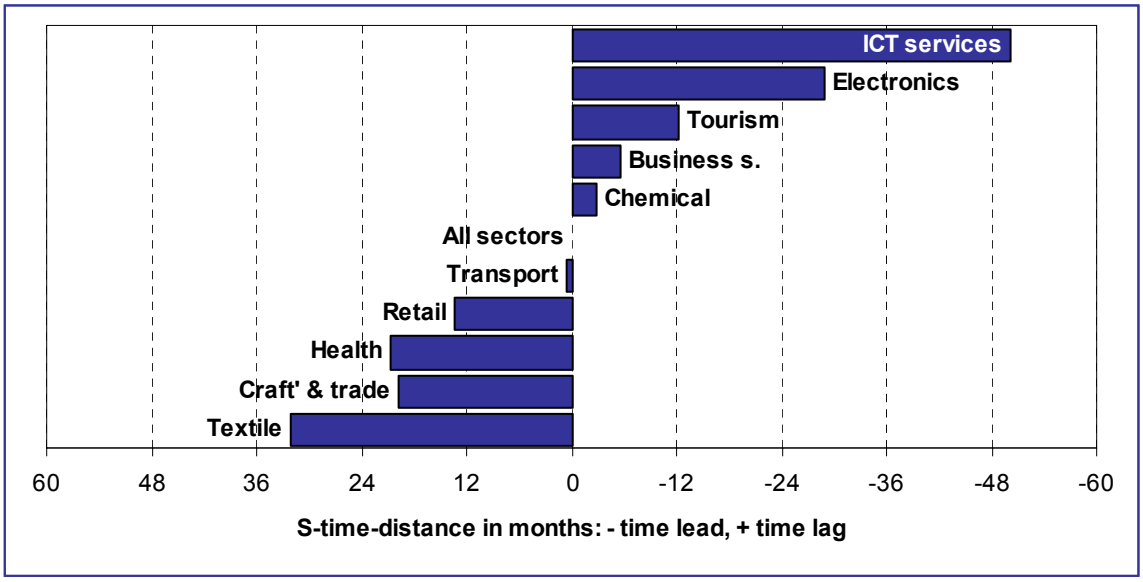
The estimation of the S-time-distance values in Exhibit 5-5 follows an approximation that is different for units above the benchmark and for units below the benchmark. For the sectors with higher values in 2003 than the average, the level of comparison is that of the benchmark unit and the negative values indicate the time lead of these sectors. For the sectors with lower values of the indicator, their respective level of the indicator is the level for which time distance is estimated. This means that time distance indicates the lag of these sectors behind the benchmark, i.e. how many years earlier had the average for all sectors attained the 2003 level of the indicator for a given sector. The same is true for other years. One should mention that the yearly values in the Exhibits in this case study refer to the March values of the respective year.

The values of S-time-distances in Exhibit 5-5 are presented in months. The respective values for sectors from the benchmark for March 2003 are presented in Exhibit 5-6. The two outstanding sectors in diffusion of buying online are ICT services and electronics. Their time lead against the values for all sectors has been increasing in the analysed period and in March 2003 the lead for ICT services amounted to 50 months and for electronics to 29 months, which is to more than 4 years and about 2.5 years respectively. A border case between these two sectors and the next group of sectors, which are rather close to the average values for all sectors, is tourism. The 2003 value for tourism shows a time lead of about 1 year.

The diffusion of online buying for the second group of sectors (business services, chemicals and transport) is very much in line with diffusion for the average of all sectors. In March 2003 the time lead or time lag for these sectors from the benchmark was just a few months, less than half a year. The other four analysed sectors (retail, health, craft & trade and textile) form

the third group which is lagging the average diffusion for all sectors from 13 to 32 months, respectively.

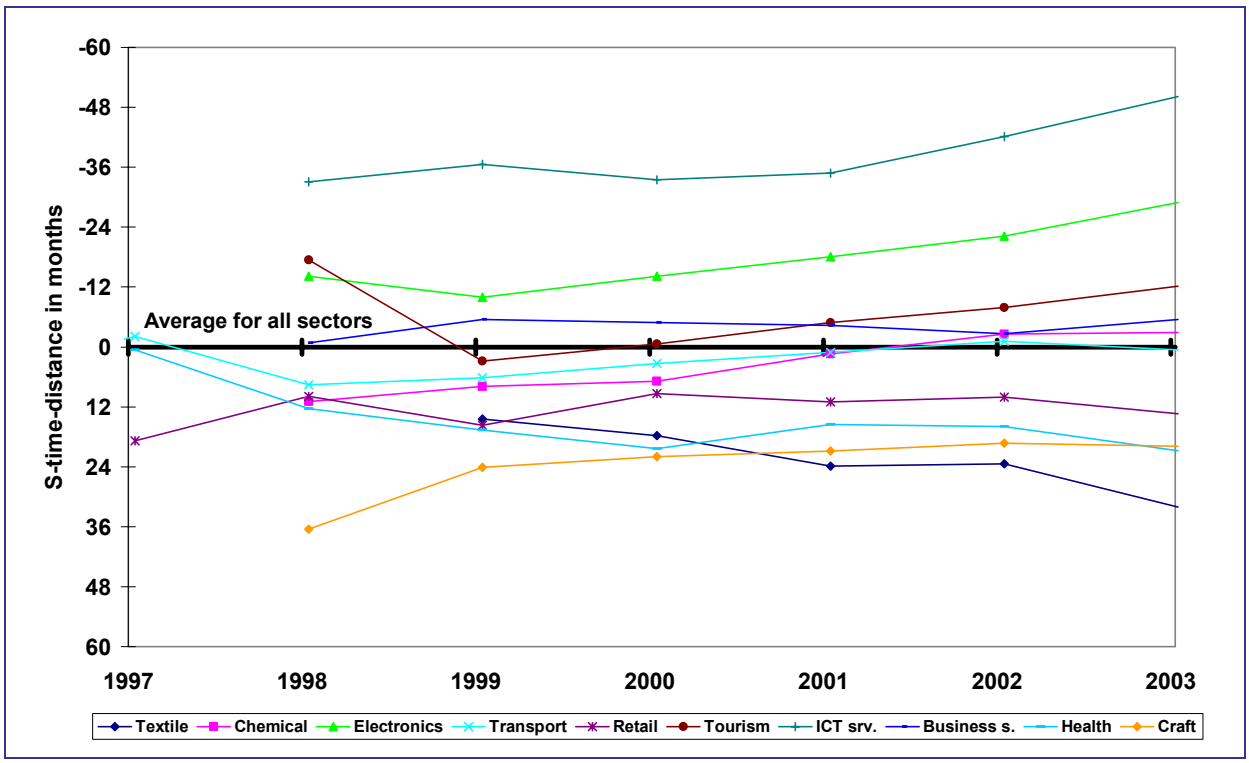
Exhibit 5-6: Time lead and time lag for the 10 analysed sectors for percentage of online buying from the average for all sectors for March 2003



Source: SICENTER / *e-Business W@tch* (2005)

The development of time distance over the analysed period is visually presented in Exhibit 5-7, which confirms both the grouping of the sectors by the magnitude of the S-time-distance from the benchmark of the average value for all sectors as well as its change over time.

Exhibit 5-7: S-time-distances for buying online for sectors compared with the average percentage of diffusion for all sectors (- time lead, + time lag for the respective sector, average=0)



Source: SICENTER / *e-Business W@tch* (2005)

Exhibit 5-8 is an empirical example for the time matrix for a given level of the indicator. It is an application of the generic idea that databases can be analysed also by levels of the indicator. This is the focus of attention on which the time distance methodology is based. For percentage of enterprises buying online levels of penetration rates in steps of 5% were arbitrarily selected and by the interpolation of original time series of *e-Business W@tch* data for the period 1995-2003 the respective times were calculated.

Exhibit 5-8: Time matrix for buying online for sectors by specified levels of percentage of enterprises

Level	ICT services	Electronics	Tourism	Business services	Chemical	All sectors	Transport equipment	Retail	Health	Craft' & trade	Textile
5	Nov-95	Dec-97	Jul-98	Jun-98	May-99	**Sep-98**	Mar-99	Sep-99	May-00	Jun-00	Feb-00
10	May-97	Dec-98	Jan-00	Aug-99	Jun-00	**Jan-00**	Apr-00	Nov-00	Apr-01	Aug-01	Dec-01
15	Apr-98	Jul-99	Aug-00	Aug-00	Feb-01	**Dec-00**	Jan-01	Oct-01	Apr-02	Jul-02	
20	Jul-98	Jan-00	Mar-01	Apr-01	Aug-01	**Sep-01**	Sep-01	Aug-02			
25	Nov-98	Jun-00	Sep-01	Mar-02	Feb-02	**May-02**	Apr-02				
30	Feb-99	Nov-00	Mar-02	Oct-02	Dec-02	**Mar-03**					
35	Jun-99	Mar-01	Oct-02								
40	Oct-99	Sep-01									
45	Feb-00	Mar-02									
50	Jun-00	Feb-03									
55	Oct-00										
60	Feb-01										
65	Sep-01										
70	Jul-02										

Source: SICENTER / *e-Business W@tch* (2005)

The advantage of such a time matrix table is its graphical quality of presentation, providing a number of observations to a searching mind. It has table-graph combination qualities. It is sometimes very difficult to observe details in a trend graph when you have 11 or even more units in a figure. Not all possible comparisons from such a table-graph will be mentioned here, but only a few. First, one immediately sees which levels were reached by the analysed sectors. Second, one also grasps over how many level classes the sectors have advanced in the time span of the period of the analysis. Third, for a given level of the indicator one could read off the S-time-distance value for that level: e.g. the level of 30% for all sectors was in March 2003 more than 4 years behind the ICT services sector and one year behind the tourism, etc. but the time distance with the average for all sectors at that level cannot be determined since e.g. the textile sector has not reached that level yet (for details on possible analysis of such time matrix see Sicherl, 2003).

Exhibit 5-1 showed also the yearly growth rates of the online buying for all sectors. Obviously the yearly growth of percentages of enterprises buying online is exceptionally high, one deals with a very dynamic process. This characteristic has also important consequences for analysing the differences between developments in different sectors. Such high rate of growth of percentage of enterprises buying online cannot be sustained for a long time. The rates of growth of the indicator for the period 2000-2003 show a decline as compared to the previous period. This will be examined in more detail on the example of buying online for the ICT services sector which has reached the highest percentage of all sectors. However, the conclusions will be relevant also for other sectors in the future.

Exhibit 5-9 and Exhibit 5-10 show in more detail the comparison of the ICT services sector with the average for all sectors. The large difference in absolute levels is obvious, but the dynamics has at the end of the period already started to show some characteristics of slower rate of growth at the high levels of the penetration rate for an indicator with an upper limit of 100.

Exhibit 5-9: Diffusion in buying online in percentage of enterprises

	Percentage		Yearly growth rate	
	ICT services	All sectors	ICT services	All sectors
1995	2.3	0.9		
1996	6.7	1.4	187	52
1997	9.5	1.9	43	38
1998	14.4	3.5	50	87
1999	32.4	6.6	126	88
2000	46.4	10.8	43	62
2001	62.1	16.8	34	57
2002	68.1	24.1	10	43
2003	74.5	30.3	9	26

Source: SICENTER / *e-Business W@tch* (2005)

Exhibit 5-10: Various measures of difference between buying online for ICT sector and average for all sectors

Time	Absolute difference (ICT srv. – All sectors)	Relative measure (index All sectors=100)	S-time-distance (All sectors=0), - time lead for buying months	
			in months	in years
1995	1.4	256		
1996	5.3	484		
1997	7.7	503		
1998	10.8	405	-33	-2.7
1999	25.7	487	-37	-3.0
2000	35.7	432	-34	-2.8
2001	45.2	369	-35	-2.9
2002	44.0	283	-42	-3.5
2003	44.3	246	-50	-4.1

Source: SICENTER / *e-Business W@tch* (2005)

Even the absolute difference between the ICT services sector and the average for all sectors has showed a very small decline in the last years. The most important difference is in the growth dynamics, where the buying online for the ICT services sector already fell below 10% per year, while the rate of growth for all sectors is still higher than 20%. There are two repercussions from this development of growth dynamics. The first, which is most obvious, is that the relative static measure of disparity has fallen from 503 in 1997 to 246 in 2003. On the basis of static measures one could say that absolute differences are not increasing anymore and that relative differences are falling. The S-time-distance, however, has increased in the last two years; in the 1998 it was 33 months, in March 2003 50 months.

Theoretically it can be shown that, with other things being equal, higher rate of growth means lower values and lower rate of growth means higher value of S-time-distance. This is a dynamic phenomenon which is not at all observed if one looks only at time series of absolute

or relative static measures of disparity. In building up the perception about the magnitude of the gap in online buying between a given sector and another sector or average of sectors as in this specific case all these measures, including S-time-distance should be evaluated simultaneously. In coming up to an overall assessment subjective weights will be used by decision makers of how to combine various measures of a complex situation.

When comparing time distances among enterprises of different size the pattern with respect to buying online is not the same throughout the period. In the beginning it was the large enterprises (250+) which started with buying online, but by year 1999 the medium size enterprises have taken the lead over the large enterprises. Only in 2001 the diffusion of buying online was again higher in the large enterprises, which have continued to lead after that. For that reason for the estimate of time distances for buying online by the size of enterprises in Exhibit 5-11 the large enterprises were taken as the benchmark.

It is of interest to observe that the time lags of small and medium enterprises behind large enterprises in 1997 were about 18 months. This is an indication of the time lead of large enterprises at the beginning of the diffusion process of buying online at a rather very low percentages of enterprises engaged in purchasing online. As mentioned above, this process of leading and lagging of diffusion by the size of enterprises has reversed until 2001. After that, the time lead of large enterprises has started to increase substantially. In March 2003 the medium enterprises were lagging for about one year (the size 50-249 for 11 months and 10-49 for 16 months); the small enterprises (size 1-9) were lagging for more than 2 years.

Exhibit 5-11: S-time-distances in months for buying online by size of enterprises compared with the percentage of diffusion for large enterprises (250+ employees)

Time	1-9	10-49	50-249	250+
1997	19	17	18	0
1998	11	9	-1	0
1999	5	-2	-5	0
2000	9	0	-5	0
2001	12	4	2	0
2002	19	8	6	0
2003	27	16	11	0

(benchmark: large enterprises = 0; other size-bands: - time lead / + time lag compared to large enterprises)

Source: SICENTER / *e-Business W@tch* (2005)

E-Business survey 2003 provides also the estimates of percentages of enterprises buying online for five EU countries. Within the group of these five countries, the UK was the leading country and for this reason we have used the UK as the benchmark country for calculating the time distances between countries. The results are presented in two ways.

shows the estimates of S-time-distances from the values experienced in the UK. Germany is following the UK rather close; the time lag has been around one year, sometimes less. Italy and France are in a similar relative position to the UK; their time lag has been about 2 years. Spain lags the UK for about three years.

Exhibit 5-12: S-time-distances in months for buying online by countries compared with the diffusion for the UK (- time lead, + time lag from benchmark UK, UK=0)

Time	UK	DE	IT	FR	ES
1997	0	12			
1998	0	9	26	28	31
1999	0	11	19	21	41
2000	0	14	22	22	29
2001	0	7	20	29	34
2002	0	6	24	31	38
2003	0	14	26	25	37

(benchmark: UK = 0; other countries: - time lead / + time lag compared to UK)

Source: SICENTER / *e-Business W@tch* (2005)

Another way of presenting the time dimension of disparity of diffusion in buying online for these five countries is the time matrix by specified level of the indicator which was explained methodologically in more detail in relation to the Exhibit 5-8. As explained there the corresponding values of S-time-distances for the specified levels of the indicator can be derived by subtracting the respective times for each specified level for any two or more countries that we wish to compare.

Exhibit 5-13: Time matrix for buying online for countries by specified levels in percentage of enterprises

Level	UK	DE	IT	FR	ES
5	Aug-97	May-98	Mar-99	Apr-99	Dec-99
10	Aug-98	Aug-99	Jun-00	Sep-00	Jun-01
15	Apr-99	May-00	Jan-01	Nov-01	Jun-02
20	Apr-00	Dec-00	Mar-02	Jul-02	
25	Dec-00	May-01	Jan-03	Jan-03	
30	Jun-01	Nov-01			
35	Oct-01	Jun-02			
40	Mar-02				
45	Jan-03				

Source: SICENTER / *e-Business W@tch* (2005)

5.3 Online selling activity

As discussed in Section 5.1 the percentage of enterprises selling online is considerably less than the percentage of enterprises buying online. The respective yearly rates of growth are presented in Exhibit 5-1. Over the whole analysed period, 1995-2003 the average rate of growth was very high for both.

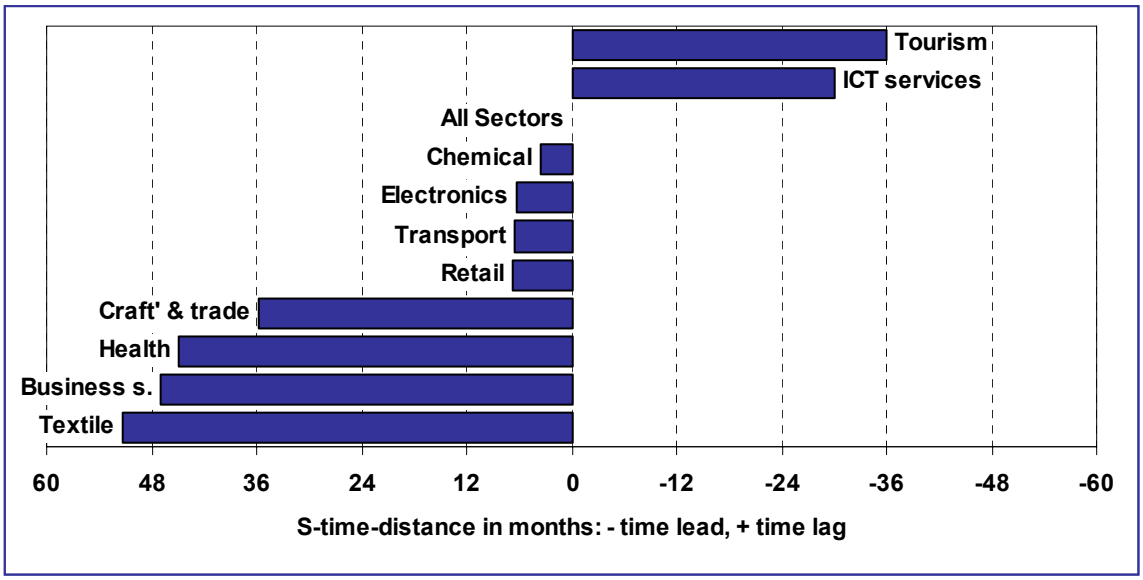
Exhibit 5-14: S-time-distances in months for selling online for sectors compared with the average percentage of diffusion for all sectors (- time lead, + time lag for the respective sector, average=0)

Time	1996	1997	1998	1999	2000	2001	2002	2003
Tourism					-33	-27	-32	-36
ICT services			-24	-24	-27	-18	-23	-30
All sectors	0	0	0	0	0	0	0	0
Chemical		-8	-17	0	-5	3	-1	4
Electronics			-23	-19	-12	-6	-6	6
Transport equipment			7	0	-4	5	9	7
Retail				19	23	1	8	7
Craft' & trade					35	32	29	36
Health				21	33	34	34	45
Business services				10	20	30	37	47
Textile						38	45	51

Source: SICENTER / *e-Business W@tch* (2005)

The respective average rates of growth for that period were 55% for buying online and 51% for selling online. In the last year of the period, however, the rate of growth of selling online surpassed that of buying online. Thus not withstanding the large difference in the percentage of enterprises engaged in these two activities, the very fast rates of growth is a common characteristic of both of them.

Exhibit 5-15: Time lead and time lag for the 10 analysed sectors for percentage of online selling from the average for all sectors for March 2003



Source: SICENTER / *e-Business W@tch* (2005)

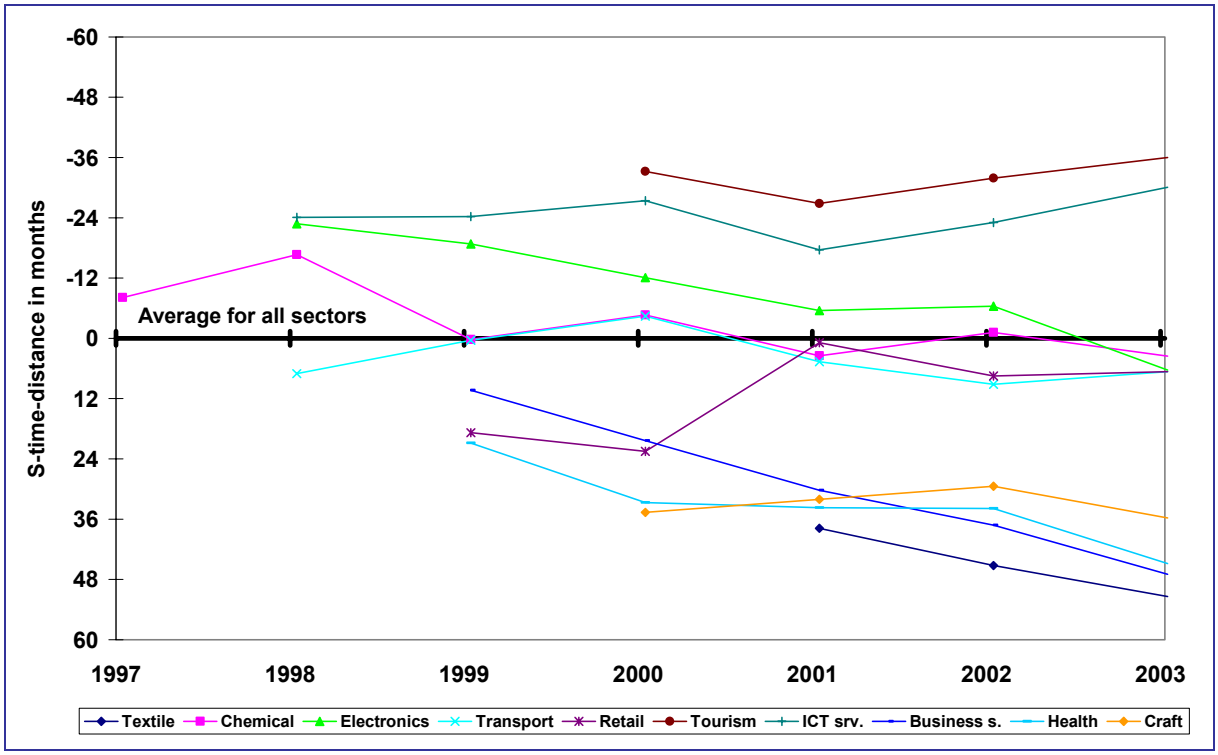
There are three groups of sectors with respect to the time lead or time lag from the average for all sectors. The leading sector in March 2003 is tourism, with a time lead of about 3 years, followed by ICT services sector with a time lead of 2.5 years. These two sectors, especially tourism, are clearly ahead of all other sectors.

The second group is the group rather near to the average for all sectors and is comprised by chemical, electronics, transport and retail sector. Their time lag behind the average is about half a year. The third group is distinctly lagging the others from 36 months (craft & trade) followed by health and business services and textile, which lags for the whole 51 months.

Exhibit 5-16 shows the development of S-time-distances for selling online for sectors over time. The two leading sectors, tourism and ICT services have been in the lead through the analysed period. At the beginning of the period electronics has also been showing an important time lead as compared to the average but at the end of the period it has fallen below the average. For the four slowest sectors of diffusion of selling online it is characteristic that the time lags behind the average and of course behind the two leading sectors has been increasing over time.

What is a characteristic of selling online by sectors is that the lagging four sectors are still at a very low level of diffusion of selling online, three of them have not yet reached the 2% diffusion level. Thus Exhibit 5-17 shows a much more uneven development of selling online by sectors as the corresponding Exhibit 5-8 presenting buying online by the percentage of enterprises. The relative static disparities are very large, the percentage of enterprises of selling online in tourism is more than 10 times higher than in the four mentioned lagging sectors and four times higher than the average percentage for all enterprises. Yet even with these huge relative static disparities, because of the high rate of growth of the selling online, the respective range of time lead and time lag from the average for all sectors has stayed between the lead time of 3 years and the lag of 4 years behind the average.

Exhibit 5-16: S-time-distances for selling online for sectors compared with the average percentage of diffusion for all sectors (- time lead, + time lag for the respective sector, average=0)



Source: SICENTER / *e-Business W@tch* (2005)

Exhibit 5-17: Time matrix for selling online for sectors by specified levels in percentage of enterprises

Level	Tourism	ICT services	All sectors	Chemical	Electronics	Transport equipment	Retail	Craft' & trade	Business services	Health	Textile
1		Aug-96	**Aug-98**	Apr-97	Oct-96	Sep-98	Apr-00	Mar-01	May-00	May-01	May-02
2		Aug-97	**Sep-99**	Jul-99	Jun-98	Jul-99	Jul-00	Feb-02			
3	Dec-97	Jul-98	**Jun-00**	Apr-00	Oct-99	Apr-00	Oct-00				
4	Jul-98	May-99	**Nov-00**	Jan-01	Jun-00	Apr-01	Jan-01				
5	Jan-99	Oct-99	**Apr-01**	Jul-01	Oct-00	Dec-01	Jul-01				
6	Jun-99	Mar-00	**Nov-01**	Nov-01	Mar-01	Jul-02	Jun-02				
7	Sep-99	Jun-00	**May-02**	May-02	Feb-02	Dec-02	Dec-02				
8	Jan-00	Aug-00	**Nov-02**	Jan-03							
9	Apr-00	Oct-00									
10	Jun-00	Dec-00									
11	Aug-00	Feb-01									
12	Oct-00	Jun-01									
13	Dec-00	Jan-02									
14	Mar-01	Aug-02									
15	Apr-01	Jan-03									
…	…										
20	Nov-01										
25	May-02										
30	Dec-02										
33	Mar-03										

Source: SICENTER / *e-Business W@tch* (2005)

With regard to the experience of selling online by enterprises of different size it is of interest to observe that, except in the beginning of the period, the medium size enterprises (10-49) have from 1999 been for some years very much in line with the large enterprises. The only distinct group with about time lag of two and a half years are small enterprises (1-9), but even they are increasing with a very high rate of growth.

Exhibit 5-18: S-time-distances in months for selling online by size of enterprises compared with the percentage of diffusion for large enterprises (250+ employees)

Time	1-9	10-49	50-249	250+
1996				0
1997				0
1998				0
1999		-2	7	0
2000	57	-3	4	0
2001	19	-2	6	0
2002	24	6	10	0
2003	30	11	15	0

(benchmark: large enterprises = 0; other size-bands: - time lead / + time lag compared to large enterprises)

Source: SICENTER / *e-Business W@tch* (2005)

Exhibit 5-19: S-time-distances in months for selling online by countries compared with the diffusion for Germany

Time	DE	IT	UK	ES	FR
1996	0		-7		
1997	0	10	5		
1998	0	12	9		4
1999	0	11	4	11	16
2000	0	19	7	19	20
2001	0	12	7	17	22
2002	0	17	16	22	28
2003	0	16	18	21	36

(benchmark: DE = 0; other countries: - time lead / + time lag compared to DE)

Source: SICENTER / *e-Business W@tch* (2005)

In comparison among the five countries, Germany stands out as the leading country in diffusion of selling online. In the Exhibit 5-19 it is shown that Italy and the UK are lagging for about 17 months, Spain for 21 months and France by 3 years. In comparison with buying online the lead role is from the UK now changed to Germany and with respect to the largest time lag Spain and France have changed their relative position.

Exhibit 5-20: Time matrix for selling online for countries by specified levels in percentage of enterprises

Level	DE	IT	UK	ES	FR
1	Jun-98	Jun-99	Aug-98	Jul-99	Oct-99
2	Dec-98	Jun-00	Apr-99	Jun-00	Sep-00
3	Jul-99	Oct-00	Jan-00	Dec-00	May-01
4	Jan-00	Feb-01	Jul-00	Jun-01	Jun-02
5	May-00	Jul-01	Nov-00	Feb-02	
6	Sep-00	Jan-02	May-01	Jun-02	
7	Dec-00	May-02	Apr-02	Oct-02	
8	Apr-01	Sep-02	Sep-02	Jan-03	
9	Aug-01	Jan-03	Feb-03		
10	Dec-01				
11	May-02				
12	Oct-02				
13	Mar-03				

Source: SICENTER / *e-Business W@tch* (2005)

5.4 Policy conclusions

The conclusions arising from this pilot case study of applying time distance methodology to analysis of adoption of e-commerce activity by sectors on the basis of data from the *e-Business W@tch* survey can be arranged in two groups. The first group relates to the specific conclusions which are brought about by applying time distance methodology to this particular data set. The second group summarises general observations about the potential benefits that the time distance methodology may bring as a complementary methodology to the analysis and measurement in a variety of fields at macro and micro levels.

Specific / general	Conclusions and observations
Specific conclusions from the pilot study on e-commerce adoption	• S-time-distance method can be applied to data on e-commerce adoption. • If "digital divides" are measured as a time lag in the adoption (as compared to static differences at a certain point of time), their assessment regarding policy implications can be quite different. • S-time-distances for e-commerce activities of companies (both for selling and buying online) are considerably larger between sectors than between countries. This confirms the importance of a sector-specific analysis. • In terms of time-distance, online selling activities have started about 3 years later than online purchasing. However, this does not say that online selling will necessarily reach the same level.
General observations on potential benefits of the S-time-distance method for policy making	• The S-time-distance method is a useful presentation tool for policy analysis and debate. It is easily understood by policy makers, managers, media and the general public. • The methodology offers an improvement at both conceptual and application levels. • Disparities may be very different in static terms and in time distance, which may lead to different conclusions in terms of policy relevance.

Specific conclusions for e-commerce adoption

First, in applying the time distance methodology to this pilot case study several conclusion were arrived at complementing the conclusions that can be derived from the application of usual methods. New results provided an additional perspective to the problem without replacing results based on other methods.

- A novel generic statistical measure S-time-distance with clear interpretability added **new information from existing data** to what information has been provided from the usual measures, such as static absolute or percentage differences of the gap, growth rates. For instance, the absolute difference in buying online in March 2003 between the UK and Spain is large (adoption rates 46.3% and 19.5%, respectively), so is the static relative disparity expressed as index with value of 238, but the S-time-distance amounts only to about 3 years. Thus, in a dynamic framework the **perception of gaps may be a different one**, as the degree of disparity may be different in static terms and in time.

- For a realistic policy evaluation of the situation, dynamic and static **measures should be used simultaneously**. In particular, the overall growth rate is an important factor that determines time lags.
    - For instance, because of a very high growth rate over the period for online purchasing activity, the perception of substantial gaps between sectors based on static measures is complemented by the perception of a much smaller degree of the gap when the time distance perspective is introduced.
    - On the other hand, even if adoption among lagging sectors is growing relatively faster than that of the leading sectors and thus the relative disparity would be decreasing, **the S-time-distances may be increasing if the overall growth rate would be decreasing more sharply**.
- The reality is clearly more complex than the usual one-dimensional static approach can deal with appropriately. The reason for different directions of change in various measures was the dynamics at the end of the period: buying online for the ICT services sector already fell below 10% per year, while the rate of growth for all sectors is still higher than 20% (but much slower than at the beginning of the period). At the high levels of the penetration rate for an indicator with an upper limit of 100 one should expect that time distances will become larger.
- The estimates of **S-time-distances are considerably larger between the sectors than time distances between countries**. This applies to buying online and selling online. For penetration rates of buying online, the sector characteristics are more important than size of the enterprise or country. The largest gap in buying online – between the UK and Spain – amounts to about 3 years.
- Online selling activity is throughout the period considerably less than buying online, but the new additional conclusions brought about by the time distance methodology are very similar to that for buying online as far as the effect of the very high growth rate of the indicator is concerned. In very approximate terms one can say that **selling online for average for all sectors has started about 3 years later than buying online** but the average rate of growth of the indicator for selling online has not been lower than for buying online. However, S-time-distance is a measure of time lags for a given level of the indicators in the statistical sense and not as a functional relationship between the compared units.
- Since relative static disparities between sectors are larger for selling online than between sectors for buying online, also **S-time-distances for the lagging sectors are larger than for buying online**. The percentage of enterprises of selling online in tourism is more than 10 times higher than in the four lagging sectors (crafts and trade, health, business services and textile). Yet, because of the high growth rates, the respective range of time lead and time lag from the average for all sectors has stayed between the lead time of 3 years and the lag of 4 years behind the average. Again, time distance perspective shows a different picture than the static measures.

General conclusions

Second, the pilot case study leads to more general conclusions about the possible benefits and usefulness of application of time distance methodology (Sicherl 2004a, 2004c, 2004d).

- As events are dated in time, the notion of this special category of time distance is a rather natural perspective in time series analysis such as comparisons, gap analysis, regressions, models, forecasting, scenarios and monitoring. The novel time distance methodology proposes a **new perspective** to the problem, an additional statistical

measure, and a **presentation tool** for policy analysis and debate that is readily understood by policy makers, managers, media and general public.

- The perceptions formed and the decisions, behaviour and actions undertaken are also influenced by the quantitative indicators and measures used in the semantics of discussing the issues, in setting the targets and in following their implementation. The understanding of the complexities of real life situation is not increased only by an increase of quantity and/or quality of empirical information. At least equally important are the concepts and tools of analysis that systematise and transform information into **perceptions relevant for decision making** and influencing human behaviour. The better the analytical framework the greater the information content provided to experts, decision makers and general public.
- The novel time distance methodology offers an improvement at both **conceptual and application levels**. This is not only a question of statistics and database analysis. It profoundly affects also the analytical and decision-making level by providing new insights for evaluation of policy and business alternatives. Expressed in time units, S-time-distance is comparable across variables, fields of concern, and units of comparison.
- Empirically, the degree of **disparities may be very different in static terms and in time distance**, which provides new insights from existing data. The present state-of-the-art neglects this additional information – although it has always been available in time series databases as "a hidden dimension" – and thus leads to an information loss that has no justification.
- This is not a methodology oriented towards a specific substantive problem, but an additional view to many problems and applications. In an information age a **new view of the existing databases** should be evaluated as an important contribution towards a more efficient utilisation of the available information. This would be complementing, rather than substituting, the existing methods in extracting the relevant information content as well as new insights from available data.
- S-time-distance approach is theoretically **universal**, intuitively **understandable** and immanently **practical**. It is well placed to complement, rather that to replace, conventional measures and thus to provide a broader concept to look at the data and to compare situations, improve visualisation, describe scenarios and monitor progress in a truly dynamic conceptual and analytical framework.