Special Issue Study

A Guide to ICT Usage Indicators
Definitions, sources, data collection and challenges involved

Including 2 Case Studies on
a) e-Commerce S-Time-Distance Statistics
b) Correspondence Analysis

July 2005
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 of collecting 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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Acknowledgements

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Bonn / Brussels, April 2005

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Introduction to the e-Business W@tch

e-Business W@tch – observatory and intermediary since late 2001

The European Commission’s e-Business W@tch monitors the adoption, development and impact of electronic business practices in different sectors of the economy in the enlarged European Union. The background of this initiative was the eEurope 2002 Action Plan, which provided the basis for targeted actions to stimulate the use of the Internet for accelerating e-commerce, acknowledging that "electronic commerce is already developing dynamically in inter-business trading" and that "it is important for SMEs not to be left behind in this process." The eEurope 2005 Action Plan confirmed and built further upon these objectives with Action 3.1.2 "A dynamic e-business environment", which defined the goal "to promote take-up of e-business with the aim of increasing the competitiveness of European enterprises and raising productivity and growth through investment in information and communication technologies, human resources (notably e-skills) and new business models".

It is against this background that the European Commission, Enterprise & Industry Directorate General, launched the e-Business W@tch in late 2001. The objective of this initiative is to provide sectoral analysis based on empirical research, including representative enterprise surveys in countries of the European Union, the EEA and Accession States, with special emphasis on the implications for small and medium-sized enterprises (SMEs).

Since its launch, the e-Business W@tch has published more than 50 e-Business Sector Studies on 17 different sectors of the European economy, three comprehensive synthesis reports about the status of electronic business in the European Union, two statistical pocketbooks and various other resources (newsletters, special issue reports, etc). These are all available on the website at www.ebusiness-watch.org.

The quantitative analysis about the diffusion of ICT and e-business is based to a large extent on regular representative surveys among decision-makers in European enterprises. The 2005 survey covers more than 5000 enterprises from 10 different sectors across 7 EU member states. In addition, more than 70 case studies on e-business activity in enterprises from all EU, EEA and Accession countries are carried out, to complement the statistical picture by a more detailed analysis of current e-business practices.

Survey results of the previous years have confirmed the initial assumption and rationale of the e-Business W@tch that the sector in which a firm operates and the size of a company, rather than its location, are the main determinants of its e-business activity. The large demand for the various publications and statistics provided by the e-Business W@tch, and their exploitation by other research institutions (for example, in the EITO Yearbook 2003 and in the OECD Information Technology Outlook 2004), document the demand for sectoral e-business analysis. Facilitated by positive responses and the growing interest in its analysis, the e-Business W@tch is increasingly developing from an observatory into a think-tank and intermediary, stimulating the debate about the economic and policy implications of e-business among stakeholders at an international level.

The wide-angle perspective: e-Business W@tch provides the "big picture" as a basis for further research

The mission of the e-Business W@tch is to present a "wide-angle" perspective on e-business developments and practices in the sectors covered. This has important implications regarding the level of detail in which various issues can be explored, both in terms of the quantitative picture (survey) and in terms of the qualitative assessment and background research.

Over the past 10 years, "electronic business" has increased from a very specific to a very broad topic to be studied. The OECD proposes a definition of e-business as "automated business processes (both intra-and inter-firm) over computer mediated networks". This definition is useful as it makes clear that
e-business is more than e-commerce (which focuses on commercial transactions between companies and their customers, be it consumers or other companies) and that e-business includes internal processes within the company as well as processes between companies. Furthermore, the OECD definition implicitly indicates that the focus and main objective of electronic business is to be found in business process automation and integration, and the impacts thereof.

This implies that the potential scope for e-business analyses has also broadened. The measurement of e-commerce transactions (the volume of goods and services traded online) can and should be complemented by studies analysing the degree to which business processes, including intra-firm processes, are electronically linked to each other and have become digitally integrated. Hence, it becomes practically impossible to cover in depth all areas and facets of e-business in one study. Thus, study scope needs to be carefully defined.

The e-Business W@tch Sector Studies apply a wide-angle perspective and zoom into selected aspects of electronic business only. In general, studies with a wide-angle approach allow for a wider range of issues to be covered and investigated at the same time. This, however, necessarily limits the level of detail in which each single issue is explored. This must be considered when using the Sector Studies prepared by the e-Business W@tch.

The role of economic analysis in the Sector Reports

In addition to the analysis of e-business developments, the e-Business W@tch Sector Studies also provide some background information on respective sector. Following the configuration of the sector (on the basis of NACE Rev. 1.1 classification) at the introduction of each study, this overview includes some basic industry statistics, as well as information about the latest trends and challenges concerning the specific sector. Readers should not mistake this background information, however, as the main topic of analysis. An e-Business W@tch "sector report" is not a piece of economic research on the sector itself, but a study focusing on the use of ICT and e-business in that particular sector. The introduction to the sector is neither intended to be, nor could it be a substitute for more detailed and specific industrial analysis.

The data presented in each sector’s overview are mainly derived from official statistics prepared by Eurostat, but are processed and refined by DIW Berlin. The purpose is to close the many gaps that occur in the official statistics, with missing data being imputed on the basis of extrapolations and own calculations.

The mission of the e-Business W@tch is to monitor, analyse and compare the development of e-business in different sectors of the European economy – not the sectors themselves. Its objective is to provide reliable results, based on commonly accepted methodologies, which are not readily available from other sources and would trigger the interest of policymakers, researchers, and other e-business stakeholders for more in depth analyses (or statistical surveys).

The e-Business W@tch has adopted a “wide-angle” perspective in its approach and the necessary trade-offs are transparently depicted in all its deliverables.

The definition of sectors and the adequate level of aggregation

Economic sectors constitute the main level of analysis for e-Business W@tch. In 2005, the sample consists of ten sectors. Their configuration and definition are based on the NACE Rev. 1.1 classification of business activities.

The rather broad aggregation of different business activities into sectors in 2002-2004 made it possible to cover a broad spectrum of the economy, but also caused some challenges for the analysis of e-business developments. For instance, it was hardly possible to focus on individual sub-sectors in much detail within a single sector report. The selection and definition of sectors proposed for 2005 reflect these concerns. Six out of the ten sectors proposed are sub-sectors that were part of
(aggregated) sectors analysed in 2002-2004. The rationale for "zooming in" on former sub-sectors is that the broad picture for the whole sector is now available from previous sector studies, and that this seems to be the right time within the prospective life-cycle of the e-Business W@tch to focus the analysis on more specific business activities.

The 10 sectors covered in 2005 were selected on the basis of the following considerations:

- The current dynamics of electronic business in the sector and the impact of ICT and electronic business, as derived from earlier e-Business W@tch sector studies.
- Interest articulated by the industry in previous years on studies of this type.
- Policy relevance of the sector from the perspective of DG Enterprise & Industry.
- Roll-out strategy of 2003: New sectors (not covered in 2002/03 and/or 2003/04) have been added, as well as specific industries which have only been covered as part of a larger sector in the past.

In 2005, the e-Business W@tch will also deliver four cross-sector studies. These Special Reports will focus on a particular e-business topic of interest across different sectors rather than on a single sector.

**The 10 sectors analysed in 2005**

The 10 sectors which are being monitored and studied in 2004/05 include seven manufacturing, construction and two service sectors. Four of these sectors have been covered in the previous years of implementation, while the other six were covered as well, but as part of (aggregated) sectors analysed in 2002-2004.

<table>
<thead>
<tr>
<th>Sector Studies</th>
<th>NACE Rev. 1</th>
<th>Publication date(s) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food and beverages</td>
<td>15</td>
<td>July 2005</td>
</tr>
<tr>
<td>2 Textile industry</td>
<td>17, 18</td>
<td>July 2005</td>
</tr>
<tr>
<td>3 Publishing and printing</td>
<td>22</td>
<td>July 2005</td>
</tr>
<tr>
<td>4 Pharmaceutical industry</td>
<td>24.4</td>
<td>July 2005</td>
</tr>
<tr>
<td>5 Machinery and equipment</td>
<td>29</td>
<td>July 2005</td>
</tr>
<tr>
<td>6 Automotive industry</td>
<td>34</td>
<td>July 2005</td>
</tr>
<tr>
<td>7 Aerospace</td>
<td>35.3</td>
<td>Sep. 2005</td>
</tr>
<tr>
<td>8 Construction</td>
<td>45</td>
<td>July 2005</td>
</tr>
<tr>
<td>9 Tourism</td>
<td>55, 62.1+3, 92.3+5</td>
<td>Sep. 2005</td>
</tr>
<tr>
<td>10 IT services</td>
<td>72</td>
<td>July 2005</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Special Topic Reports</th>
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<tbody>
<tr>
<td>A A User's Guide to ICT Indicators: Definitions, sources, data collection</td>
</tr>
<tr>
<td>B International Outlook on E-Business Developments</td>
</tr>
<tr>
<td>C E-Business Standards and Interoperability Issues</td>
</tr>
<tr>
<td>D ICT Security and Electronic Payments</td>
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</tbody>
</table>

* There will be 1 report (in 2005) on 4 of the 10 sectors, and 2 reports on the other six.
Executive Summary

Constructing meaningful ICT indicators – a challenge for statistics

The rapid adoption of information and communication technologies (ICT) in business, and the objective of anticipating 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 sources for ICT market statistics in Europe.

- **Statistics on ICT investment**: measurement of the aggregate investments by firms 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 mainly addresses 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 population** 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, for instance by employment or turnover?

- **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 that 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 (adopter 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 losing 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:

<table>
<thead>
<tr>
<th>Policy objective</th>
<th>Suggestions for policy</th>
</tr>
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</table>
| 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 I: A User's Guide to ICT Indicators and Indices

1 Introduction

This report provides an overview of recent developments in measuring the adoption and use of information and communication technologies (ICT) in enterprises. It can be regarded as a meta-study to the regular activity of e-Business W@tch, which is the study of sectoral e-business implications. e-Business W@tch has been a player in the field of ICT and e-business measurement itself since 2002. The initiative has carried out primary research on ICT adoption by European companies and contributed to the debate on adequate methodologies and instruments for this purpose.

The report explores the state-of-play in the development of ICT indicators and data collection. The background and rationale for this effort is the assumption that the information economy (or knowledge economy) is the currently dominant "economic style" in the sense of Kondratieff's long waves of economic development. In the information economy, ICT are a key technology for producing economic benefits, for instance by increasing the productivity of firms. Against this background, adequate measures on the adoption, use and impact of ICT are important for policy-makers to anticipate trends and to assess the economic and social implications of this development.

Analysis concentrates on international efforts in official statistics and in research to develop adequate metrics for measuring the use and impact of ICT in firms. This includes relevant work of the OECD, by Eurostat and research projects within the RTD Framework Programmes of the European Union. Special attention is paid to the issue of composite indicators, their promises and challenges. As a concrete example of innovative approaches describing knowledge society developments, the report features a pilot study on "Sectoral Time-distances in the adoption of e-commerce activity", based on e-Business Survey results. This pilot was contributed by Professor Pavle Sicherl, SICENTER, Slovenia.

Objectives of the report

The main objectives of this report are to provide an overview of the state-of-play in ICT and e-business measurement, and to introduce alternative perspectives for presenting statistics on ICT diffusion. The report mainly addresses policy-makers who occasionally work with ICT statistics, rather than ICT experts themselves. It explicitly does not address statisticians, as they are fully familiar with the issues presented in this report. Instead, the report addresses the average user of ICT statistics who will normally not be a statistical expert.

More specifically, the report has the following goals:

- To outline the main underlying concepts ("ICT", "e-business") and a rationale for measuring these concepts;
- To explain the main challenges in developing ICT indicators;
- To offer some practical guidelines for good use of ICT indicators that stem from enterprise surveys;
- To provide an overview of the state-of-play in ICT measurement, including activities in official statistics and in research;
- To present relevant examples of different approaches for developing and collecting ICT indicators (studies, initiatives);
To discuss the merits and risks of **compound indicators**, and to offer practical guidelines for developing and using them;

- To present **innovative methods** on how to better visualise ICT indicators, including a pilot study employing e-Business W@tch data.

Except for the last point, i.e. the pilot study on S-time-distances, and in contrast to the e-Business Sector Studies, this report is not based on primary research. It is a literature and desk-research study.

### 1.1 Concepts and definitions

There are no commonly established, agreed and concise definitions for the terms "information society", "information economy", "knowledge society" and "knowledge economy". The underlying concepts are so broad, but also ideologically loaded, that clear-cut definitions that could be shared and accepted by a majority of the research and policy community are simply not possible. The common denominator of all approaches to create a framework for these concepts is that information and communication technologies play an important role.

**ICT – the 5th Kondratieff**

The Kondratieff model of long waves of economic development\(^1\) is a useful framework to conceptualise the information society and economy, which constitutes the fifth such wave of development since 1850. The "ICT Kondratieff" started in the late 1970s or early 1980s. Innovation in information technology constituted the driving force to change the Fordist economic style of the Fourth Wave. As the duration of one long wave is normally between 40 and 60 years, the ICT Kondratieff can be expected to last for about another 20 years before it will gradually be replaced by a new economic style.

**Exhibit 1-1: Long waves of economic development (Kondratieff)**

<table>
<thead>
<tr>
<th>1st Kondratieff</th>
<th>2nd Kondratieff</th>
<th>3rd Kondratieff</th>
<th>4th Kondratieff</th>
<th>5th Kondratieff</th>
</tr>
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<tr>
<td>1800</td>
<td>1850</td>
<td>1900</td>
<td>1950</td>
<td>1990</td>
</tr>
<tr>
<td>Steam engine</td>
<td>Railway Steel</td>
<td>Electrical</td>
<td>Petrochemicals</td>
<td>Information and</td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
<td>engineering,</td>
<td>Automobiles</td>
<td>communication</td>
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<td></td>
<td></td>
<td>Chemistry</td>
<td></td>
<td>technology</td>
</tr>
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A: Irruption phase: emergence of the new technological and economic style
B: Growth phase: broad adoption, maturity, economic upswing
C: Turning point: saturation, begin of decline
D: Paradigm change: economic recession, leading to new style

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\(^1\) Nikolai Dmitrijevitich Kondratieff (1892 - 1938), a Russian economist, proposed a theory (1935) that Western capitalist economies have long term (40-60 year) cycles of boom followed by depression. The deployment of new cycles is triggered by technological innovation. Today, these cycles are referred to as "Kondratieff waves".
The economic developments since the 1990s fit the Kondratieff model very well. The prosperous growth of the 1990s, driven by information and communication technologies, and the frenzy of the new economy, are typical of the latter part of the prosperity phase after a new economic style has emerged. The burst of the dotcom bubble in 2001 represents a striking turning point for the current wave of economic development. The next phase is typically characterised by economic downturn, recession and even depression, before a new economic style emerges. If the model holds true, and if the duration of the current wave will not drastically shorten compared to previous waves, sustained economic upswing cannot be expected for the next 10 years. Many researchers also argue that health and life sciences will be the determinants of the new economic style to emerge in the forthcoming 6th Kondratieff.

Data, information and knowledge

The debate of semantic differences between "data", "information" and "knowledge" has filled many reports of this volume. The practical merits of this type of exercise are questionable, however. Most definitions that make a difference between these terms establish a kind of value chain. "Data" constitutes the raw material within this chain. Value is then added by processing data and using it in practical contexts. Compared to "data", "knowledge" has a much more complex connotation. Knowledge is a multi-dimensional concept which includes the aspects of experience and practical applicability. "Knowledge is the capability to take decisions using the information that is available at the decision time." (NewKind, 2002, p.3) Thus, the term knowledge captures the cognitive context. "Information" often takes a middle position between "data" and "knowledge", but is also used as a synonym for either of the two terms.

While the distinction of these terms can be important for studies in social sciences and linguistics, it has little or no practical value for economic studies and studies on the diffusion of information and communication technologies (ICT). For practical reasons, it is therefore proposed not to make a difference between "information" and "knowledge" in the context of this report, as far as the terms refer to the information/knowledge society and to the information/knowledge economy.

The term Information Society was introduced in the 1970s in connection with the development of digital computing, but has gained political and academic momentum interest mainly since the early and mid 1990s. The "Bangemann-Report" ("Europe and the Global Information Society. Recommendations to the European Council" from May 1994, and the G7 Meeting on the Information Society in Brussels (1995) are milestones in this development that triggered policy processes with far-reaching implications for Europe, for example the telecommunication liberalisation.

2 The statement reflects the author's opinion. Social scientists have diverse views on this issue.
3 The Reports on "The Information Economy" by Marc Porat (1977) and on the "Informatisation of Society" by Nora & Minc (1978), are considered as key documents constituting the information society paradigm in research and policy-making, respectively.
**Excursus:**

**The measurement of intangibles**

In the broader framework of the knowledge based economy, the possibility and importance of measuring investments into intangibles has been debated by the research, policy and business communities. "Intangibles" include areas such as research and development, a firm's know-how and knowledge management, the use of software, brands, licenses, copyrights, and organisational design. While there is broad agreement that these domains are key drivers of both competitive advantage and economic value creation, it is extremely difficult to develop adequate metrics for quantifying related investments and, even more so, for comparing the deployment of intangible assets between different companies. Research has addressed this issue under different topics and in different contexts, for example as part of the debate on "human capital" and its measurement.

In this context, it has been proposed that the "EU should take steps towards building a better understanding of their fragmented and generally hidden productive processes", and that there is substantial requirement for statistical offices to extend data collection on intangible assets.

The link between intangibles and ICT arises from the rapid penetration of ICT in business, which is viewed as a key enabler of all the observed changes. On a macro-economic level, the main argument is that intangible assets enable knowledge-intensive economies to maintain their competitive position and to out-perform resource or labour intensive economies. Thus, against the background of globalisation, there could be a major implication for policy and business to strengthen the base of intangible assets in European companies.

However, the concept of measuring intangibles is much broader than the measurement of ICT adoption and, possibly, e-business activity – which is the subject of this report. It is a different area of research and statistical activity. Statistics on ICT adoption and use are only a sub-segment within this research discipline.

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**Defining the information / knowledge economy**

The information society can be studied and measured from different perspectives (social, technological, economic, spatial, occupational), but these are clearly intertwined, for example the economic and occupational dimension. The economics of information has become an acknowledged sub-division within economics. In the tradition of Fritz Machlup (1962) and Marc Porat (1977), indicators have been specified to measure the contribution of knowledge and information-producing industries to wealth creation. Indicators seek to quantify the economic significance of "information", separating the economy's information-related components from the non information-related ones.

Thus, there are two basic concepts of the "information / knowledge economy": a narrow concept and a broader concept, depending on whether the term is applied to the overall economy, or to measure specific business activities as part of the overall economy (see Exhibit 1-2).

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**Exhibit 1-2: Broad and narrow concept of the information/knowledge economy**

<table>
<thead>
<tr>
<th>Broad concept</th>
<th>Narrow concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>The “knowledge economy” is not restricted to a certain segment of the economy, but is a term that characterises the dominant economic style of the 5(^{th}) Kondratieff. Thus it refers to the overall economy in the information age.</td>
<td>The “knowledge economy” consists of specific segments of economic activity. It can be measured as a share of the total economy. Typical segments of the knowledge economy are education, research and development, media and communication services, manufacture of information and communication devices, and information services (software, legal, consulting).</td>
</tr>
</tbody>
</table>

‡ Suggestion: The term “knowledge-based economy” could be used if the broad dimension is meant. ‡ Suggestion: The term “knowledge industries” (or “sectors”) could be used if the respective part of the overall economy is meant.

These two concepts are commonly confused, as there is a significant amount of research on both aspects, which normally specify their own working definitions. A pioneer milestone in the record of measuring the knowledge economy in the narrow sense was Fitz Machlup's work on "The Production and Distribution of Knowledge in the USA" (1962). Machlup defined five sub-sectors that comprise the knowledge industries: education, research and development, media and communication, information machines, and information services (including legal, engineering, accounting/auditing and medical services). These business activities can be defined by standardised classifications of business activities, such as NACE Rev. 1.1.\(^7\)

The reference to this earlier research shows that the study of information and knowledge as an economic factor is not so new after all. The nature and importance of knowledge and information have changed considerably, however, since personal computers made their way into households and businesses. In recent years, the OECD has made substantial efforts to develop adequate definitions and methods for measuring the information economy (cf. OECD 2002, 2004a, 2004b) and electronic business activity (OECD 2004a, p. 105-140).

The OECD includes both manufacturing and service activities in its industry-based definition of the ICT industries, based on the International Standard Industry Classification (ISIC) Revision 3\(^8\), cf. Exhibit 1-3. In most OECD countries, this sector was found to be "relatively small, although it has grown rapidly over the 1990s". For the year 2000, the share in business employment ranged from 3.7% (in Portugal) to 11.3% (in Finland), while the share in value added was found to be higher. (OECD 2004b, p. 21f.)

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\(^7\) NACE Rev. 1 is a 4-digit activity classification which was drawn up in 1990. It is a revision of the "General Industrial Classification of Economic Activities within the European Communities", known by the acronym NACE and originally published by Eurostat in 1970.

\(^8\) The International Standard Industrial Classification of All Economic Activities (ISIC) is a hierarchically structured system of business activities, recommended for global application. NACE has been derived from ISIC Rev. 3, harmonised with Rev. 3.1, and can thus be regarded as the "European ISIC".

Exhibit 1-3: OECD Definition of the ICT industries

<table>
<thead>
<tr>
<th>ISIC code</th>
<th>Business Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>Manufacture of office, accounting and computing machinery</td>
</tr>
<tr>
<td>3130</td>
<td>Manufacture of insulated wire and cable</td>
</tr>
<tr>
<td>3210</td>
<td>Manufacture of electronic valves and tubes and other electronic components</td>
</tr>
<tr>
<td>3220</td>
<td>Manufacture of television and radio transmitters and apparatus for line telephony</td>
</tr>
<tr>
<td>3230</td>
<td>Manufacture of television and radio receivers, sound and video recording</td>
</tr>
<tr>
<td>3312</td>
<td>Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes</td>
</tr>
<tr>
<td>3313</td>
<td>Manufacture of industrial process control equipment</td>
</tr>
<tr>
<td>5150</td>
<td>Wholesale of machinery, equipment and supplies</td>
</tr>
<tr>
<td>7123</td>
<td>Renting of office machinery and equipment (including computers)</td>
</tr>
<tr>
<td>6420</td>
<td>Telecommunications</td>
</tr>
<tr>
<td>7200</td>
<td>Computer related activities (hardware and software consultancy, software supply, data processing, database activities, maintenance and repair of office, accounting and computing machinery, other)</td>
</tr>
</tbody>
</table>

Source: OECD (2004). The Economic Impact of ICT. p. 21

Indicators for the information economy

With the advent of the personal computer and the Internet, the scope of the subject under study has broadened. The macro-perspective of studying the size of the ICT industries as a whole is complemented by a meso- and micro-perspective which constitute different focal points for ICT measurement. Accordingly, a basic distinction can be made between the following generic categories of ICT related statistics (cf. Exhibit 1-4):

- Indicators on the size of the ICT industries as a segment of the whole economy
- Indicators on the size and development of ICT expenditure (either investments by enterprises or household expenditure)
- Indicators on the use of ICT use by enterprises or households
- Indicators on the availability, price and quality of ICT services
### Exhibit 1-4: Generic categories of ICT statistics

<table>
<thead>
<tr>
<th>Focus on:</th>
<th>&quot;ICT industries&quot;</th>
<th>&quot;ICT investment / expenditure&quot;</th>
<th>&quot;ICT use&quot;</th>
<th>&quot;ICT services&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main objective</strong></td>
<td>Measurement of the contribution of the ICT sector(s) to the overall economy</td>
<td>Measurement of the aggregate expenditure by firms and/or households on ICT</td>
<td>Measurement of ICT adoption by enterprises or households and description of related activities (particularly in the case of enterprises)</td>
<td>Measurement of the availability, price and quality of ICT services, particularly telecommunication services</td>
</tr>
<tr>
<td><strong>Units of observation</strong></td>
<td>Sector(s)</td>
<td>Consumers (total) industry</td>
<td>Companies</td>
<td>Service providers</td>
</tr>
<tr>
<td><strong>Perspective</strong></td>
<td>Supply-side</td>
<td>Demand-side</td>
<td>Demand-side</td>
<td>Supply-side</td>
</tr>
<tr>
<td><strong>Challenges</strong></td>
<td>Harmonisation of industry statistics</td>
<td>Segmentation of the industry: definition of the &quot;ICT industries&quot; (e.g., services and manufacturing?, …)</td>
<td>Data availability (expenditure data), choice of adequate method</td>
<td>The multitude of different tariffs and service packages makes any comparison difficult. Convergence between different types of services.</td>
</tr>
<tr>
<td><strong>Main data sources</strong></td>
<td>Official statistics</td>
<td>Retail sales</td>
<td>Enterprise surveys</td>
<td>Information from service providers</td>
</tr>
<tr>
<td><strong>Indicators (examples)</strong></td>
<td>ICT industries in % of GDP</td>
<td>Expenditure for computer hardware</td>
<td>Internet access</td>
<td>Prices for mobile communication services</td>
</tr>
<tr>
<td></td>
<td>Total production value and value added</td>
<td>Expenditure for software and services</td>
<td>e-Commerce activity (online sales, online procurement)</td>
<td>Quality of mobile networks</td>
</tr>
<tr>
<td></td>
<td>Employment in ICT industries</td>
<td>Telecommunication expenditure (services)</td>
<td>Use of special software (CRM, SCM)</td>
<td></td>
</tr>
<tr>
<td><strong>Data providers in EU (examples)</strong></td>
<td>EITO</td>
<td>EITO</td>
<td>Eurostat</td>
<td>ITU (Internat. Telecom. Union)</td>
</tr>
<tr>
<td></td>
<td>Structural Business Statistics (Eurostat)</td>
<td>OECD (as data aggregators)</td>
<td>e-Business @@tch</td>
<td>OECD</td>
</tr>
<tr>
<td></td>
<td>OECD (as data aggregators)</td>
<td>CIS (Community Innovation Survey) by EU</td>
<td>National monitoring initiatives</td>
<td></td>
</tr>
</tbody>
</table>
1.2 The role of ICT indicators for policy

When the political agenda further propelled the issue of information society developments, statisticians from different statistical bodies, as well as academia, had already been engaged in exploring statistical measurement of the underlying concepts. These developments led to the recognition of the necessity for a common European (and possibly international) approach in monitoring the information society. These activities set the frame, for example, for the Surveys on ICT use in households and in enterprises within Eurostat's Information Society research area.

There are two main reasons why policy is closely monitoring ICT adoption and electronic business developments. The first consideration is that these developments can coincide with European or national policies, particularly in the following areas:

- The regulatory environment for telecommunication services;
- Innovation and technology policy;
- Education and labour market policy;
- The role model of the public sector;
- Other policy areas which may possibly overlap with electronic business developments (e.g. patenting law, trade regulations).

The second reason is that ICT and electronic business may not only interfere with the policy areas listed above, but are considered to have an impact on economic development in general. The main assumptions are that ICT are a key driver for innovation, and that adoption (or non-adoption) by enterprises may thus have an impact on productivity, competitiveness and growth. If so, policy has a role to stimulate and promote ICT adoption by enterprises. Following this rationale, EU Member States and many regions within the Member States have adopted e-business policies.

Against this background, the Enterprise and Industry Directorate General of the European Commission has undertaken a substantial effort to systematize e-business policies with respect to their objectives, targets and contents. The "Go Digital" campaign can be regarded as the starting point and initial background of this activity. In March 2003, the Commission issued the Communication "Adapting e-business policies in a changing environment: The lessons of the Go Digital initiative and the challenges ahead", to stimulate a target-oriented policy-making process and debate in this area. The Communication outlined a framework for SME specific e-business policies that consists of three main challenges and nine related objectives. Based on this work, DG Enterprise and Industry has started to benchmark national and regional e-business policies, in particular as part of the activities of the e-Business Support Network (e-BSN, www.e-bsn.org).

In this context, ICT indicators are an important instrument for policy in several ways. First, quantitative data are needed to "map" the status quo, possibly by comparing the situation with other regions or countries. Second, data are required to understand and assess the dynamics of the development, and to monitor the progress achieved over time. There is considerable debate among policy-makers and business intermediaries as to what extent e-business related policies can and should involve quantitative targets. Irrespectively of the various positions being taken in this debate, it is commonly agreed that some statistics are

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9 COM(2003) 148 final
10 In this context, a study on "Impact Assessment of e-Business Policies" was launched by DG Enterprise and Industry in late 2004 in order to assess the outcomes and impacts of 10 e-business policy initiatives in EU countries.
absolutely needed as background information, and that benchmarking can be a useful instrument in policy-making processes.

For e-business policies, surveys are the main vehicle to provide these statistics. The following chapter explains some of the challenges that have to be faced when carrying out such surveys, and provides recommendations to users of the results.

1.3 From questions to indicators: challenges for ICT surveys

What is an "indicator"?

An indicator is designed to represent and provide quantitative information about a construct of interest which itself cannot be directly measured. The objective is to be able to compare elements of a set of categories with each other – for instance country with country, sector with sector, or small with large enterprises, and to be able to follow trends in the construct over time.

Before specifying indicators, it may be necessary to break down a construct – a complex social and/or economic category – into dimensions. These represent the different elements and features of a complex social construct. For instance, "e-business" can be regarded as a construct with different dimensions such as customer-facing processes, supply-side processes, and internal business processes.

On the side of indicators, the reverse process of breaking down a construct into dimensions is to re-aggregate individual indicators into an index. This index, ideally, then represents a model of the complex social or economic construct.

Exhibit 1-5: Indicators, dimensions and constructs

As shown in Exhibit 1-4 before, ICT indicators can be derived from very different types of data sources, including:

- Representative surveys
  - GPS: General Population Surveys among citizens
  - DMS: Decision-maker Surveys among any type of organization or profession (for example among enterprises, public administration authorities, teachers, hospitals, doctors)
- Industry statistics and national accounts
A Guide to Indicators on ICT Use by Firms

- Information from individual companies, e.g. about retail sales and shipments from ICT vendors
- "Baskets" of certain goods or services: Baskets are used, for example, for calculating price indices such as the consumer price index, or telecommunication costs.

As it would go beyond the scope of this report to discuss the strengths and weaknesses of each of these potential sources (for instance in terms of data accuracy, flexibility of the data collection process, timeliness of results, international comparability, continuity of the data collection) the focus is on indicators that are based on representative surveys among decision-makers in enterprises. It is the most important source for indicators about ICT adoption among enterprises.

The objectives of this chapter are to present an analytical framework for the process from "asking questions" to "presenting indicators", and to highlight some of the challenges that have to be dealt with during the various phases of this process. A proper understanding of this process can help users of indicators better understand the value and limitations of indicators.

The main phases in collecting ICT indicators through surveys

The process from planning and carrying out interviews with decision-makers in companies to finally presenting "indicators" on ICT use is long and involves many critical decisions and challenges. Exhibit 1-6 depicts the major steps in this process and highlights the critical issues that have to be addressed in each phase.

Exhibit 1-6: From questions to indicators: tasks and challenges

<table>
<thead>
<tr>
<th>Task</th>
<th>Phases</th>
<th>Output</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey set-up</td>
<td>Field-work (Interviewing)</td>
<td>Aggregation of raw data</td>
<td>Data modelling, analysis</td>
</tr>
<tr>
<td>Questions</td>
<td>Answers</td>
<td>Indicators</td>
<td>Indices</td>
</tr>
</tbody>
</table>

- **Questions**: "Does your company have Internet?" 
  - Q1: "...?" 
  - Q2: "...?" 
  - Q3: "...?"

- **Answers**: "Yes."

- **Indicators**: "Internet access in % of companies"
  - Connectivity

- **Indices**: Connectivity

- **Challenges**:
  - Complexity of issues: translating concepts to be investigated into (simple) questions. Use of open questions?
  - Sampling: Directories of target population available?
  - Resources: How many companies can be interviewed? Is the sample representative?
  - Participation level: Possible bias due to refusals of firms to participate in survey
  - Interview length: Complex issues would require more interview time (explanations, definitions) than is normally available
  - Applicability of questions: Some questions may not be applicable for parts of the target population
  - Significance / confidence intervals: particularly if an indicator is based only on a part of the sample
  - Decision on weighting: What is the adequate weighting principle? Impact of "extreme" cases (e.g. very large firms) on weighting.
  - Traps of aggregation: Correlation between component indicators, risk of over-aggregation
  - Interpretation of results: Linking the quantitative results to initial research questions, identifying key results and trends

Source: e-Business W@tch / empirica GmbH (2005)
The main challenges

The challenges depicted in Exhibit 1-6 have to be confronted whenever collecting data through representative enterprise surveys. In fact, some of these challenges are more significant in decision-maker surveys than in general population surveys, for instance the level of acceptance to participate in the survey, and the calculation of weighting schemes. Questionnaire design, decisions on sampling, and weighting are discussed in some more detail, as these are important issues for users of the data as well.

Questionnaire design

The survey questionnaire is the main instrument which is used to collect indicators through representative surveys. However, it is in many cases a big challenge to translate "research questions" into "survey questions". This is a critical step in the implementation of data collection processes, and the related challenges involved are commonly underestimated by users of ICT indicators.

Another critical challenge is the need to reduce complex concepts and research questions into "simple" survey questions. While simple concepts such as "having access to the internet" can easily be translated into a survey question, this can be difficult for more complex concepts to be investigated. For example, the topical and important issue of linking business processes electronically cannot be directly phrased as a survey question. It needs explanations and must be broken down into sub-sets.

A major challenge, particularly if telephone interviews are used as a method, is the limited interview time: the average length of an interview is normally restricted to 15-20 minutes, as otherwise the refusal rate and the stop rate (interviewees discontinuing an interview because it takes too long) increase significantly. Costs for the survey also increase. This means that there is no time for lengthy explanations or discussions of complex concepts. Questions must be straightforward and immediately understandable. Against this background it is evident why testing ("piloting") a questionnaire before launching the survey is so important, particularly when using telephone interviews.

Decision on the universe and on sampling techniques

Any survey among enterprises has to take a decision whether to include all companies or whether to make a cut-off (e.g. in terms of firm size, or by not including companies that do not use computers). As the OECD points out (2002, p. 48), results on ICT adoption rates are extremely sensitive to the sample used in a survey. In countries surveying all businesses, the smallest firms’ results will dominate due to the large number of this type of enterprises. Using cut-offs (for example to include only firms with five or more employees, as used in surveys in Denmark and Finland, or with ten or more employees as in Sweden and the UK), shifts the emphasis on smaller or larger enterprises. Clearly, if "100%" means enterprises with at least 10 employees, e-business activity will appear to be wider diffused than in a survey where "100%" means all enterprises, including micro-companies with less than 10 employees.

Weighting

In order to be able to raise the figures obtained from the interviews to national (or EU) level, some form of weighting is required to adequately reflect the structure and distribution of establishments (or related variables) in the universe of the respective country (or the European Union). The procedure used by e-Business W@tch in its e-Business Surveys can be used as an example to explain the issue. e-Business W@tch uses weighting by employment. However, other forms of weighting, for instance by turnover, are also possible.

Original weight. Firstly, within each country and sector surveyed, interviews are split according to a quota plan which guarantees that the sample is not dominated by micro- and small companies (which would be the case if random sampling without any quota would be
applied). As a consequence of this procedure, the sample of interviewees includes about 10% of large enterprises with more than 250 employees.

**Weighting (by employment).** In terms of employment, large enterprises account for much more than 10% of employees in most countries and sectors. This means that the raw data obtained through interviews need to be "weighted", if they are to be presented as employment-weighted figures. Unfortunately, the data available on the distribution of employment over enterprise size bands is very limited for most EU Member States. The e-Business W@tch uses mostly the Eurostat New Cronos database to extract the data that are necessary for weighting. Weighting variables are then linked with the indicators to produce the weighted figures. The weighted sample for each country therefore reflects employee distribution between the establishment size bands within that country. This means, for example, that an employment-weighted value of "20% in country A" should be understood to mean "enterprises accounting for 20% of all employees in country A".

Weighting by employment for an aggregate of several countries. Additionally, another weighting factor is then created to calculate average figures for all countries in the sample. Each country is represented in this weight according to its share in the total employment of the countries in which the survey is conducted.

In household surveys, different weighting issues have to be considered, for example the transformation from a household sample to a person sample. If only one person per household is interviewed, the described sample procedure provides a household sample, i.e. each household of the base population has the same likelihood of being in the sample, but not each person. With the weighting stage of the transformation, the equal likelihood of households is replaced mathematically by the equal likelihood of the individuals. In addition, an adjustment of the unweighted sample structure to the official statistics in terms of population distribution (for example age, gender or income) needs to be considered.

**Conclusions and recommendations to users**

Users of ICT indicators should possess a basic understanding of key issues and processes of data collection. This will help them to put figures into perspective and avoid misinterpretation of results. The main steps of the process and the critical issues involved have been summarized in this chapter. The following checklist (Exhibit 1-7) proposes four key questions which users of ICT statistics could ask themselves when working with data in order to make sure that they really understand their meaning.
Exhibit 1-7: Checklist for users of survey based ICT statistics

<table>
<thead>
<tr>
<th>Check whether ... is clear:</th>
<th>Notes</th>
</tr>
</thead>
</table>
| **The universe of the survey**<br>What types of companies / organizations were included in the survey? | What constitutes the target population ("universe") from which a sample has been drawn to be interviewed? In ICT surveys, it will normally be households or companies from a certain geographic area and (if companies) specific sectors. There are a number of decisions that have to be made specifically for ICT surveys in this context, for example:  
  - Whether micro-enterprises with <10 employees should be included or not in the survey.  
  - Whether enterprises (the legal entity) or establishments (the branch offices of enterprises) constitute the unit of observation. |
| **The base of a figure**<br>If a value is 28%, what exactly does "100%" stand for? | While the universe refers to the survey as a whole, the base refers to a single value that has been computed from the survey results. If an indicator value is expressed as a percentage, the "base" must be clearly specified. What exactly does "100%" stand for? It could possibly be only a part of the universe. A definition should be given, as well as the number of observations (= no. of companies interviewed) from which the percentage has been computed (often referred to as "N").  
Example: The indicator is "broadband deployment", and the value is "28%". Is it 28% of all companies, or 28% of companies with internet access, or …? The base could be specified, for example, in the following way: Base = all companies from the sector in the UK (N=800). |
| **The weighting scheme**<br>Do small and large enterprises count equally in percentages? | A figure of "70% of enterprises" can mean different things:  
  - It could be 70% of legal units (i.e. a micro-company with a few employees and a large company with thousands of employees both count equally).  
  - It could be enterprises that represent 70% of employment in the sector or country. In this case, small and large enterprises do not count equally, but their answers are weighted according to the firms' share of employment. |
| **Confidence intervals**<br>What is the statistical accuracy of the data presented? | Statistics vary in their accuracy, depending on the kind of data and sources. A "confidence interval" is a measure that helps to assess the accuracy that can be expected from data. The confidence interval is the estimated range of values on a certain level of significance (normally 95%).  
Example: If the value of an indicator is 34%, and the confidence interval is "10 percentage points on a significance level of 95%", this means that – with a probability of 95% – the real value is within a range of 29%-39%.  
Normally, the confidence interval is not specified for all individual values that are presented in a report. Some indicative guidelines could be provided as part of the methodology description, however.  
Good practice in this context is the UK International Benchmarking Study (2003). The confidence interval is specified in the introduction: Data can be expected to be accurate within a percentage of +/- 3% for the UK and +/- 5% for other countries. This means that "the margin of error makes absolute precision in the magnitude of trends occasionally difficult to obtain" (IBS 2003, p. 2). |

Source: *e-Business W@tch / empirica GmbH (2005)*
2 Indicator development and data collection: the state-of-play

The fast growing adoption of information and communication technologies (ICT) in business, and the objective of anticipating possible policy implications of this development, triggered a demand for statistical information on the diffusion of ICT in firms and about related activities. This demand has further increased since the implementation of the eEurope 2002 initiative\textsuperscript{11} and, during eEurope 2005\textsuperscript{12}, the follow-up initiative. While commercial market research companies were fast to react to this new demand, it took some time for official statistics to adopt this new field of study and to develop adequate instruments. In parallel, the issue of adequate ICT indicators has also been addressed by numerous research projects, for example within the 5\textsuperscript{th} and 6\textsuperscript{th} Framework programme of the European Union.

The growing activity of numerous players over the past few years has paradoxically led to a situation which is already perceived as an oversupply of ICT statistics instead of the former lack of data. This impression has been reinforced by a certain lack of coordination among players in terms of definitions, concepts and methods used. It took some time for the international research community to start working on a common framework for e-business definition and measurement. In the absence of a common framework, the multitude of surveys carried out in parallel created a pool of data that were hardly comparable to each other and thus confused users in policy.

However, even if significant efforts have been made since 1999 to make surveys in different parts of the world more comparable by agreeing on common standards and definitions, it will not be possible to solve this problem. There are so many decisive parameters involved in collecting ICT statistics that no two surveys which are carried out in different contexts and which are not explicitly aligned to each other will be fully comparable.

A clear distinction between indicator development and data collection would therefore be almost impossible in practice, as there is no clear division of work in terms of players and activities. A possible, notable exception to this rule is the OECD which focuses on methodological issues rather than on data collection. In most cases, however, the definition of ICT indicators goes hand in hand with the collection of underlying data, i.e. the definition is a preparatory step in operational planning.

In this chapter, important recent developments in indicator development and data collection are summarised. The presentation is structured by types of players, focusing on official statistics and on special research. The multitude of commercial studies on ICT adoption (including the multi-client studies from commercial research and consulting companies) does not allow referencing them within the scope of this study.


2.1 Official statistics and international working groups

Official statistical institutes and international research bodies have clearly recognised the need to harmonize methods of measuring ICT adoption and use in enterprises. Over the past years, considerable progress has been achieved in this respect. Activities focus on the development of adequate e-business and e-commerce definitions, the development of related indicators and the design of model questionnaires for data collection.

An important player and international coordinator of activities in this field is the OECD Working Party on Indicators on the Information Society (WPIIS), which works in close cooperation with the Voorburg Group on Service Statistics (VG – the United Nations City Group on Service statistics) and Eurostat. At the national level, statistical offices contribute to the debate and increasingly adopt the common conceptual framework and related instruments. (cf. Eurostat 2003, p. 8)

Early attempts to launch pilot surveys in this field were made mostly by industrialised countries with an advanced status of ICT adoption.

- Australia has been carrying out surveys on ICT usage by companies since 1994 and on e-commerce since 1999.
- In Europe, the Nordic countries were pioneers in setting up guidelines and pilot projects to measure ICT use in enterprises. They launched a pilot survey about ICT use and e-commerce in Nordic companies in late 1998.
- Canada started conducting surveys on the use of ICT and e-commerce in 1999.

2.1.1 Activities of Eurostat

European official statistics, including the national statistical institutes, has made an intensive effort to improve the availability of statistics on ICT and electronic business adoption of European enterprises. Data on "e-readiness", as defined in the OECD framework for measuring electronic business, and about how many enterprises use ICT for various e-business applications, are now available for enterprises from many sectors and from all EU countries.

The Eurostat ICT and e-business enterprises survey, which was piloted in 2001 and has been continued annually since, special benchmarking surveys of several Member States, particularly in the Nordic Countries and in the UK (in the context of UK Online for business), and the e-Business surveys have made important contributions to the availability of data on e-business in Europe.

However, e-business statistics still suffer from a lack of adequate indicators (and, consequently, data) on e-business intensity and, particularly, on e-business impacts. Although it is clear that collecting these data is much more complex and costly than gathering basic data on infrastructure and simple frequencies for e-business activity ("yes"/"no" questions), it will constitute the main challenge for statistics and research to come up with innovative indicators and improve the data situation with respect to these areas. In 2004 the EU introduced a regulation to ensure that information society statistics will be collected in the EU in a comparable and consistent manner.14

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13 Different approaches, and their results, will be presented in more detail in the follow-up study to this report: "International Outlook on e-Business Developments" (to be published in September 2005). In the present report, only a synoptic overview of major activities in selected non-European countries is provided.

Eurostat Survey on ICT Use in Enterprises

The Eurostat Survey on ICT Use in Enterprises, which has been carried out annually since 2002 (with a pilot in 2001), is – together with the survey on ICT Use in Households – one of the main vehicles in European statistics to collect information society indicators on a European scale.

In spring 2001, with the support of the Enterprise Directorate General, Eurostat started the preparation of surveys on ICT usage in households and in enterprises. The objective was to improve coverage of this issue within the European Statistical System. A first draft list of variables for the survey was prepared by Eurostat in May 2001, building on the list of variables proposed for an OECD model questionnaire on ICT usage of households as presented in the WPIIS meeting in April 2001. After consulting Commission Services and discussions on the list of variables/questionnaire in the Information Society Statistics Task Force in June and the Working Group in October the questionnaire was finalised in November 2001. A tabulation scheme and a short glossary was prepared and sent to countries in January 2002.

In 2001 a pilot survey was carried out jointly coordinated by Eurostat and Statistics Denmark. 13 EU Member States participated in the pilot, which focused mainly on e-business readiness (e.g., questions related to factors and barriers to ICT adoption and e-commerce) and usage (e.g., questions about making sales and purchases via the Internet or EDI). The second survey (in 2002) added more variables on e-business usage. Impact-related questions were found difficult to be included, because it is hardly possible for enterprises to determine precisely the effects of ICT on growth and productivity. (cf. Eurostat 2003, p. 9f.) Recent research initiatives by the statistical offices, and by universities and other research organisations, have taken up this task (cf. example in box: "Firm level research at UK ONS").

The 2002 ICT usage survey and the 2001 pilot survey were carried out on the basis of voluntary agreements between the European Commission and the National Statistical Institutes (NSIs). The European Commission contributed financial support in the form of grants to the Member States to partly cover the survey costs. Member States oblige themselves to provide harmonised data and meta-data, while retaining some flexibility in adapting their national surveys, e.g. by adding questions.

The Eurostat surveys have a huge scope, particularly when compared to other surveys such as those by e-Business Watch. In 2002, about 61,100 enterprises were surveyed in the participating Member States, and in 2003, about 66,200 enterprises were included (cf. Ottens 2004). For comparison: the e-Business survey 2002 covered about 9,300 enterprises, the survey 2003 about 10,500 enterprises. This is a factor of about 6. It should be noted that Eurostat surveys exclude enterprises with less than 10 employees. This has the advantage of having a more homogeneous sample for analysis. On the other hand, some information about ICT uptake in micro-enterprises has also been considered important by policy.

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15 Presented by Sheridan Roberts from the Statistical Office of Australia.
16 For this reason, e-Business Watch was explicitly requested by the European Commission to include micro-firms in its survey.
**Firm level research at UK ONS:**

**Tackling the research challenge to assess e-business impacts**

The UK Office of National Statistics (ONS) started a research programme in 2002 to assess the impacts of IT investment and ICT use on UK firm performance. Initial research was funded by the UK Cabinet Office, Eurostat, and the European Commission, DG Enterprise & Industry and looked at electronic commerce. Current research is DTI - funded and looks at IT investment, ICT use, telecommunications, and e-business.

Research uses firm level data collected by the ONS. With econometric expertise from the London School of Economics and ONS, the programme investigates IT investment behaviour and productivity effects in UK firms associated with:

- investment in computer hardware and software,
- use of e-commerce for buying and / or selling,
- use of electronic business processes,
- use of computers or the internet by employees, and
- use of telecommunications.

The innovative and ambitious programme tries to connect and exploit firm level data from the following sources:

- the Annual Business Inquiry (ABI), covering about 70,000 firms per year
- the annual Business Spending on Capital Inquiry (BSCI - from 1998), including about 2,500 firms and measures of hardware and software
- the Quarterly Inquiry on Capital Expenditure (Quarterly CAPEX), with data for about 30,000 firms
- the e-commerce survey from 2000 onwards, covering about 12,000 firms per year.

By linking together the investment sources (ABI, BSCI, Quarterly CAPEX and FAR) and by making assumptions on prior IT investment, and on rates of IT capital depreciation, it has been possible to build firm level estimates of IT capital stock for over 50,000 firms. Results show that this approach of linking sources can help identify ICT productivity impacts, and the firms where they have greatest effect.

**Sources:** Van Reenen, Sadun and Bloom (forthcoming): "IT investment and productivity, testing explanations of productivity growth"; Shikeb Farooqui (forthcoming): "ICT use by firms and employees and its productivity effects". Papers to be delivered at the ONS / CAED conference, September 2005.

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**The CIS – Community Innovation Survey**

The Community Innovation Survey (CIS) is the main instrument for collecting systematic, empirical information about the innovation activity of European enterprises. Results of the CIS are an important source and basis for innovation policy. Results of the CIS help to analyse and understand the effects of innovation on the economy, for example on competitiveness, employment, economic growth, and on trade patterns.

The CIS is not conducted annually, but in intervals of 4-5 years. It was conducted for the first time in 1992. CIS2 took place in 1996, and CIS3 in 2001. Data collection is conducted in the Member States, either by their statistical offices or by research institutes that have been appointed for this task. The results of the national surveys are synthesised and further processed by Eurostat to enable cross country comparability. To ensure strict confidentiality
of the information at the firm-level, the micro-level database remains confidential; it is only accessible to Eurostat staff.\textsuperscript{17}

The methodology of the CIS is based on the “Oslo manual”, a joint publication of Eurostat and the OECD.\textsuperscript{18} The Oslo manual is currently under revision in order to account for new orientations of European innovation policy. The next CIS is expected to contribute to a better understanding of the “non-technical” aspects of innovation, such as management techniques, organisational change, design and marketing issues.

Since 2000, the CIS has become a major data source of the “European Innovation Scoreboard” (EIS). The EIS features an annual assessment of innovation performance in the individual EU Member States. It was established upon request of the European Council meeting in Lisbon in March 2000. The EIS consists of a set of 17 qualitative indicators, covering human resources, knowledge creation, the application of knowledge and innovation finance. The EIS itself is a component in the broad benchmarking framework of DG Enterprise & Industry, which covers European enterprise policy and competitiveness as a whole. The 2004 EIS confirmed Sweden and Finland as leaders in innovation activity in the EU. Estonia and Slovenia were found to be leaders among the ten new Member States. In line with the approach of \textit{e-Business Watch}, the 2004 EIS examined for the first time the differences between various sectors in terms of innovation. The most innovative sector in the EU was found to be the electrical and optical equipment industry.\textsuperscript{19}

For 2005, the number of innovation indicators has been increased to 26. Nine out of those are new compared to the 2004 EIS. To ensure the timely updating of the scoreboard in the future, the Commission has asked the Member States to carry out the CIS more frequently.

Through the EIS, the CIS is also an important source for the "European TrendChart on Innovation". The TrendChart implements the open co-ordination approach laid down by the Lisbon Council. It provides policy-makers and managers of innovation support schemes with summarised information and statistics on innovation policies, performances and trends in Member States, and supports the exchange of good practice in this area. In this context, CIS is complemented by the survey of innovation policy measures.\textsuperscript{20}

**The SBS – Structural Business Statistics**

Although not strictly dealing with ICT issues, the SBS Structural Business Statistics by Eurostat are an important source and background information for data on ICT use by enterprises. Since the type of ICT use and e-business activity depend – among other factors – on the firm size, it is important to know the differences in the configuration of industries, within a country and across countries. SBS deliver this type of information. SBS describe the structure of the economy through the observation of the activity of units engaged in an economic activity. They provide data on wealth creation by business activity, employment, related developments, contributions to growth, and on investments. Main variables are the number of enterprises, of persons employed, personnel costs, gross investments in tangible goods, turnover, production value and value added at factor costs.

\textsuperscript{17} Cf. information about CIS on the Cordis website at \url{http://www.cordis.lu/innovation-smes/src/cis.htm} (May 2005)

\textsuperscript{18} The "Oslo Manual" is the foremost international source of guidelines for the collection and use of data on innovation activities in industry. The document (93 pages) can be downloaded from the OECD website at \url{http://www.oecd.org/dataoecd/35/61/2367580.pdf} (May 2005).

\textsuperscript{19} See: "2004 innovation scoreboard reveals little change in country rankings", \url{http://dbs.cordis.lu/epc/cgi/srchidadb?CALLER=NEWS_INNO&SESSION=&ACTION=D&RCN=EN_RCN_ID:22991} (May 2005)

\textsuperscript{20} More information, including annual country reports on innovation activity and policy, are available on the website of the TrendChart at \url{http://trendchart.cordis.lu}.
SBS was implemented in 1995 (first reference year for data). The data set was substantially extended in 1999. Thus, for many important variables, European aggregates are available from reference year 1999 onwards. The collection of structural business data, and their synthesis, is a very complex and time-consuming task. This may cause a problem for users of SBS data, since the latest available reference year is typically about 3 years prior to the publication of the respective data sets. National data are supposed to be sent to Eurostat for compilation about 18 months after the end of the reference period, but it appears that some EU Member States fail to meet their deadlines which are stipulated by council regulations.21

### 2.1.2 Activities of the OECD

The OECD has acted as a coordinator and forum for the development of internationally comparable information society statistics for more than 20 years. Methodological work covers issues such as the definition and classification of the ICT sector, definitions of e-commerce and e-business, the development of model questionnaires on ICT usage, and general guidance for the measurement of indicators of ICT (Eurostat 2003, p. 59). Within the OECD, the Working Party on Indicators for the Information Society (WPIIS) is one of the main units to carry out work in this area.

**OECD:**

**Challenges in measuring ICT investments**

The OECD has made substantial efforts in harmonizing the measurement of ICT investments. In the "Measuring the Information Economy" report, OECD comments on the many challenges in this context:

**Different statistical classifications of business activities:** The capacity to provide data according to the OECD definition of the ICT sector is a function of the similarity between national classifications and ISIC Rev. 3. While NACE, the European classification, matches ISIC at the required level of detail and provides an even finer breakdown, specific concordances and estimates have to be provided for NAICS (Canada, the United States), ANZIC (Australia, New Zealand) and SIC (Japan).

**Investment vs. consumption:** In the national accounts, expenditure on ICT products is considered as investment only if the products can be physically isolated (i.e. ICT embodied in equipment is considered not as investment but as intermediate consumption).

**Decision on hedonic adjustments, i.e. deflation methods and adjustment for quality:** The measurement of investment in real terms requires price indices that take changes in the quality of products into account. This is particularly important for products subject to rapid technological change such as computers or ICT products generally. Some statistical agencies apply so-called "hedonic" techniques to capture price changes in ICT goods, others do not.

**Scarcity of data:** Official international data on expenditure on ICT goods and services are scarce. In some OECD compilations of statistics on the information economy, private data were often used, despite some uncertainty about their quality. In principle, official estimates of household consumption and business investment in ICT should be derived from the national accounts. However, national accounts are not always sufficiently detailed to allow for the identification of investment in and consumption of ICT goods and services.

**Source:** OECD (2002): Measuring the Information Economy. p. 10-20

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Recent work of the OECD has been very influential in defining and measuring the information economy, particularly regarding efforts to harmonise international statistics. The OECD has been active in all areas of ICT statistics, including the measurement of ICT investment and of electronic business activity. In the area of ICT investments, harmonization of statistics from different countries involves considerable challenges. "Data availability and measurement of ICT investment based on national accounts (SNA93) vary considerably across OECD countries, especially as regards measurement of investment in software, deflators applied, breakdown by institutional sector and temporal coverage." (OECD 2002)

In the field measuring e-business activity, the challenge is to harmonize statistical efforts ex-ante, mainly by promoting the agreement on common definitions and survey instruments (e.g. by developing model questionnaires). The OECD has taken the role of a promoter and coordinator of such efforts.

**Joint initiative by the OECD and JRC**

The Joint Research Centre (JRC) of the European Commission (EC) and the Organisation for Economic Co-operation and Development (OECD) have launched a joint initiative to critically assess the methodologies for constructing composite indicators of country performance in different policy areas (e.g. innovation, competitiveness, globalisation).

An important output of this cooperation will be the "Handbook on Constructing Composite Indicators: Methodology and Users’ Guide", which is currently under development (publication is planned for mid 2005). Two preparatory workshops were held to discuss issues and to prepare the Handbook.22

The OECD-JRC Handbook is intended to assist both the users and builders of composite indicators. Users shall be acquainted with the nature and purpose of composite indicators, and with their advantages and disadvantages. For constructors of composite indicators, the methodological steps will be explained in detail. A toolbox will provide them with different alternatives. Methods for testing the robustness of composite indicators and for assuring their overall quality and clear presentation will also be included.23

**EBIP Project – case studies on electronic business**

OECD has also conducted qualitative research on electronic business. The Electronic Commerce Business Impacts Project (EBIP) was carried out by the OECD in 2001 and 2002. EBIP involved a set of in-depth, internationally comparable case studies that provided new insights into the dynamics and business impacts of firms' electronic commerce strategies. The project included 217 firm-level case studies from 20 sectors and 11 participating countries (Canada, France, Italy, Korea, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom).24

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22 The "1st Workshop on Composite Indicators" took place on 12 May 2003 at JRC Ispra (VA), Italy. The 2nd Workshop was held on 26-27 February 2004 at the OECD in Paris.

23 An outline of the Handbook is available on the "information server on composite indicators” of the JRC at http://farmweb.jrc.cec.eu.int/ci/Handbook.htm (May 2005), along with plenty of other information and resources on composite indicators, including methodologies, case studies, articles, books, software, events and mixed news.

24 Sector studies are available on the OECD website at http://www.oecd.org/document/21/0,2340,en_2649_33703_2539157_1_1_1_1,00.html (May 2005).
2.2 National e-business monitoring activities

In some European countries, the main ICT monitoring activity is either closely linked to or carried out as part of the Eurostat survey on ICT use in enterprises. Some of the National Statistical Offices have published results for their own country in a national report, independently from the overall survey and presentation of results. The advantage of this approach is that it is economical and that it greatly facilitates international comparability of data by aligning the data collection methodology. The disadvantage is that flexibility is limited, as there are restrictions in the selection of instruments (questionnaire), methods and in the timing of the survey. In some EU Member States, national ICT benchmarking and monitoring initiatives have been launched independently and in addition to the Eurostat survey, for example in the Nordic countries.

It was not possible within the scope of this report to gather a comprehensive overview of initiatives across Europe. Instead, the following paragraphs feature examples of national benchmarking and monitoring initiatives from France and the UK. In France, e-business developments are studied in the framework of the "Mission for Digital Economy". In the UK, the International Benchmarking Study "Business in the Information Age" (2003) by the UK Department of Trade and Industry (DTI) reports how companies from the UK perform compared to their competitors in other major economies. A good example of regional monitoring activities in EU Member States is the study on E-Commerce in Welsh SMEs. Similar activities are carried out in other countries.

2.2.1 France: Mission pour l’économie numériquê

Background

"Mission pour l’économie numérique" (MEN, Mission for Digital Economy) is a taskforce implemented by the Ministry of the Economy, Finance and Industry. MEN was launched in 2001 for an initial period of five years in order to study and to promote the development of electronic business in France, and to ensure the coordination of related activities at the level of the Ministry of the Economy, Finance and Industry.

The taskforce is put in charge of facilitating dialogue between stakeholders in the private and public sectors concerned with the digital economy, measuring the progress achieved by French companies in this field, and conducting or supporting communication campaigns to promote the widest possible extension of the digital economy. Moreover, MEN assesses whether legal frameworks have to be adapted toward changing market environments in the digital economy. With its diverse activities, the MEN contributes to the implementation of the government action programme for the information society. It is involved in preparing the French position for multilateral, Community and bilateral negotiations on the digital economy.

E-commerce Scoreboard

MEN implemented an E-commerce Scoreboard for France. The first edition of the Scoreboard dates back to November 2001 and was designed and developed by IDATE on

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The Scoreboard has been regularly updated since. The latest, sixth edition was published in December 2004. The first edition of the Scoreboard (2001) featured a synthesis of available statistics on ICT adoption among French enterprises from a variety of international sources, including France Telecom, the DTI International Benchmarking Study (see chapter 2.2.2), the OECD STI Scoreboard, and international e-commerce studies. From these sources, an assessment was derived as to how France performed in terms of ICT uptake.

The selection of indicators from these sources has been refined throughout the subsequent editions. These indicators are tracked over time whenever updates are available, which are then featured in the updated Scoreboard. "The Scoreboard is primarily a collection of indicators, i.e. regularly updated figures that have been selected because they are based on an appropriate methodology and allow for comparisons between countries, and over time. The indicators are tracked from one edition to the next. Indicator accuracy and relevance were the chief factors when selecting indicators." (E-commerce Scoreboard Update. 6th edition, December 2004, p. 4). To this end, the Scoreboard systematically contains a list of sources for each indicator, comments on the methodologies, and on their reliability.

The latest edition of the Scoreboard (37 pages) draws the following conclusions:

- **Business-to-consumer (B2C) e-commerce** is rapidly winning new customers:
  - The number of online buyers is increasing faster than the number of internet users.
  - The likelihood of buying online is linked to years of internet use.
  - There is growing trust in buying online.
  - There is an increasingly attractive supply of product and of high-profile retail websites.

- **In Business-to-business (B2B) e-commerce**, online purchasing is more widespread than online sales
  - ICT penetration still has to make deeper inroads into French SMEs.
  - In France, fewer companies have a business website relative to other EU countries such as Germany or the UK, and fewer than one in ten French businesses sell online.
  - Companies want to expand their markets and improve their supply quality

**Study on ICT diffusion in SMEs**

In 2003, a study on conditions for ICT adoption among small and medium-sized enterprises was piloted by DiGITIP, the General Directorate for Industry, Information Technology and the Post Office) working with DEcas (Direction des entreprises commerciales, artisanales et de services, Directorate for Trading, Craft and Service Enterprises). The study, which was initiated by the ICT & SME Group of the Digital Economy Task Force and conducted by Algoé Consultants in 2003/04, proposes strategies for the public sector to encourage the uptake of ICT among SMEs on three activity levels:

- **Facilitate**: for instance by addressing the requirements and preconditions for e-business, such as ICT infrastructure and e-competencies.

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• **Influence**: for instance by raising awareness, informing about opportunities.

• **Support**: for instance by advising the individual enterprise, and by launching concrete support measures such as reducing access costs.

The study points out differences in ICT related challenges for SMEs according to the overall market situation and the competitive scenario in which a company operates. It identifies 8 segments of enterprises and points at specific actions which would be needed to trigger ICT update in these firms. This segmentation was then further elaborated into specific profiles for each of the segments\(^{29}\).

<table>
<thead>
<tr>
<th>SME Segment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>Enterprises doing business in a sector subjected to the pressure of globalisation</td>
</tr>
<tr>
<td>Type B</td>
<td>Enterprises earning a substantial share of their turnover in exports</td>
</tr>
<tr>
<td>Type C</td>
<td>Enterprises competing with imported goods and services on the domestic market</td>
</tr>
<tr>
<td>Type D</td>
<td>Enterprises doing business with a limited number of national or regional customers</td>
</tr>
<tr>
<td>Type E</td>
<td>Enterprises doing business on a diffuse, national B2B market</td>
</tr>
<tr>
<td>Type F</td>
<td>Enterprises doing business on a national B2B market</td>
</tr>
<tr>
<td>Type G</td>
<td>Regional or local enterprises belonging to a pool of enterprises or representing a limited number of suppliers</td>
</tr>
<tr>
<td>Type H</td>
<td>Independent regional or local enterprises doing business on a local or regional market</td>
</tr>
</tbody>
</table>

The study developed an ICT pre-diagnosis tool for SMEs, which is broken down into a questionnaire and a spreadsheet. Consultants can use the tool to promote the ICT awareness of entrepreneurs by suggesting an exhaustive report on the ICT stakes and usage of the enterprise. The tool requires the consultant to have a degree of proficiency in the matter. A special action-training initiative in conducting an ICT pre-diagnosis in an SME can help hone consultant's skills in this area.

### 2.2.2 UK: International Benchmarking Study

The "International Benchmarking Study: Business in the Information Age" (IBS) is regularly conducted by the UK Department of Trade and Industry (DTI). The latest studies (2003, 2004) were carried out by Booz Allen Hamilton.

The 2004 study compares ICT adoption and use in 11 countries (the UK, Australia, Canada, France, Germany, Italy, Japan, the Republic of Ireland, South Korea, Sweden and the USA). The study is based on survey data of businesses in these countries. About 2,700 companies in the UK were interviewed about their use of ICT, and about 500 companies in each of the other 10 countries. With this sample, resulting data can be expected to be accurate within a percentage of +/- 3% for the UK and +/- 5% for other countries.

In many ways, the study is similar to the e-Business survey. It adopts the same size-bands of enterprises (0-9, 10-49, 50-249, 250+), and the survey focuses on aspects of ICT and e-business that are comparable to the modules of the e-Business Surveys 2003 and 2005 by e-Business W@tch. Also, survey results have been weighted to reflect employee distribution, which takes into account the economic importance of the businesses involved.

The main goals of this series of benchmarking studies include "understanding how businesses in leading economies are utilising ICT, and benchmarking the UK against these economies" (IBS 2004, p. 4), and "to provide a basis for informing e-business policy-making in the UK" (IBS 2003, p. 1).

The IBS series started as early as 1997. Originally, IBS was conceived as a programme to regularly measure the progress towards achieving the government's goal of "making the UK the best environment in the world for e-commerce", a target set in the 1998 Competitive White Paper of the UK.

A special achievement of the IBS 2003 was the calculation of a Sophistication Index. After piloting such an index in the IBS 2002, the 2003 study has enhanced the index based on interviews with researchers, government and industry representatives. The new index is a compound of 54 indicators on e-business activity. The Index has been developed in response to the Communication from the European Commission on "Adapting e-Business Policies in a Changing Environment" from March 2003. The index is based on two established concepts in its structure:

- The "Three-Pillars Approach (TPA)", identifying people, technology and processes as the critical building blocks of the index.
- The "Technology Innovation Life Cycle Approach (TILA)", stating that technology adoption has the following phases: awareness, adoption, deployment, and impact.

An innovation of the IBS 2004 was that the report examined for the first time sectoral differences in the adoption and use of ICT, thus enabling a deeper investigation of the underlying themes. Furthermore, the Sophistication Index was enhanced by amendment of existing indicators to capture new ICT, an increased focus on ICT sophistication, and changes in the scoring of various indicators (IBS 2004, p. 6).

The 2003 and 2004 studies each identified some major trends as a conclusion from the empirical observations (p. 10f):

<table>
<thead>
<tr>
<th>IBS 2004: major trends</th>
<th>IBS 2003: major trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>More businesses are measuring the benefits of technology: These increases are indicative of businesses becoming more sophisticated in the way they use ICT. The earlier focus on costs following the dot.com crash is now being replaced by a more holistic approach to the assessment of ICT investments.</td>
<td>The end of the &quot;dash for access&quot;: As most companies had connected to the internet by 2003 (about 90%), it meant connected access per se was no longer a key metric of a nation's advancement in ICT.</td>
</tr>
<tr>
<td>Businesses are becoming more selective in the type of information that they provide and the activities that they perform online: Firms focus more on applications that deliver measurable benefits, such as order fulfilment and payment, and cutting back on the provision of non-core information.</td>
<td>The death of the &quot;perceived value of presence&quot;: In previous years, a market asymmetry was found for business attitudes to the value of the internet. In 2003, businesses widely believed that the internet and ICTs could help them to cut costs, but few saw a great potential for boosting revenues. Micro- and small firms in particular were found to take a hard look at costs, even for website maintenance.</td>
</tr>
<tr>
<td>Businesses appear to have become more responsive to competitors and the wider business community: The proportion of businesses that rate competitors as a major driver for ICT implementation has increased on average by 14 percentage points.</td>
<td>Emphasis on ICTs delivering business value: It was found that in many cases businesses freeze further investment in ICT, while focusing on enhancing the underlying business processes enabled by ICT.</td>
</tr>
<tr>
<td>Significant differences in the level of ICT adoption across sectors: The sector analysis has identified significant variations in the level of technology adoption and deployment across sectors. In general, financial services businesses were found to have the highest levels of adoption and connectivity, whilst businesses in the primary and construction sectors typically have the lowest.</td>
<td>The new digital divide – smaller businesses are struggling: Interviews revealed different dynamics in medium-sized and large companies on the one hand, and micro- and small enterprises on the other. The connectivity environment in many small firms was found to be close to that of consumers, for instance in terms of broadband availability.</td>
</tr>
</tbody>
</table>
2.2.3 Regional benchmarking: E-Commerce in Welsh SMEs

The study "E-Commerce in Welsh SMEs – the State of the Nation Report 2003/2004" was conducted by the e-Commerce Innovation Centre (eCIC) at Cardiff University within its role as a Centre of Excellence and in the context of the Opportunity Wales project. It is the follow-up study to a similar exercise carried out in 2002/03.

The main aims of the research for 2004 were to measure the progress of Welsh SMEs in implementing e-commerce and to enable development of future support service provision in Wales. SMEs (defined as firms employing up to 250 people) have a high social and economic importance in Wales, accounting for approximately 70% of all Welsh private sector employment. Adoption of electronic commerce is considered to be a key driver of economic growth and increased productivity within the SME community in Wales.

Three broad indicators were considered to assess the adoption and use of e-commerce in Welsh SMEs, in line with the OECD framework of e-commerce measurement developed in 1999: readiness, intensity and impact.

- "e-commerce readiness" investigates potential usage and access by measuring technical infrastructures necessary and in place, skills, expected benefits and perceived obstacles to e-commerce
- "e-commerce intensity" examines the utilisation of e-commerce technologies and opportunities by measuring the frequency, value and nature of transactions;
- "e-commerce impact" considers the impact of e-commerce by looking at, for example, perceived benefits, efficiency gains and new products and services.

A random sample of 28,816 SMEs across Wales was drawn, comprising all businesses with a telephone line including those which are not VAT registered. The study was commissioned to investigate e-commerce adoption and use within SMEs only, therefore businesses with more than 249 employees were excluded. Businesses operating in administration, education and health sectors which could clearly be identified as public sector organisations and non-commercial organisations such as charities were also removed from the sample.

For the survey a self-administered postal questionnaire which had been tested in a pilot was sent to a random sample of SMEs across Wales. All respondents were given the opportunity to receive a printed summary of the results of the survey. In order to improve the response rate, a follow-up mailing was conducted. An initial response rate of 11.5% was achieved. A key aim of the 2003/04 study was to provide a more detailed geographic breakdown of responses by individual Unitary Authority; a minimum response of 100 completed surveys in each individual authority was advised in order to ensure reliable results.

2.2.4 ICT surveys in the new EU Member States

Even before joining the European Union in May 2004, the process of aligning the statistics systems of the new Member States to become part of the EU statistical system had already begun, including the alignment of ICT statistics. In 2003, five of the new EU Member States (Czech Republic, Latvia, Lithuania, Slovakia and Slovenia) and one Candidate Country (Romania) had reported carrying out an ICT-related survey on enterprises in the year 2002. Out of these, Czech Republic, Latvia, Lithuania and Romania had already based their surveys on Eurostat's methodological recommendations.

In the remaining countries, ICT-related sections had been embedded in other business surveys or initiatives, such as the Structural Business Survey (e.g. in Slovakia) or the RIS – Regional Innovation Strategies programme of the European Union (in Slovenia). (cf. Eurostat 2003, p. 46)
ICT surveys in the new EU MS

Alignment of the statistical systems

The new Member States have quickly been integrated in the activities of the European Union with regard to ICT statistics. In some countries, alignment had begun already before joining the EU.

In the Czech Republic, two enterprise surveys on ICT usage and e-commerce were carried out by the Czech Statistical Office: a pilot survey in 2002 (with reference years 2000-2002) and a regular annual survey in 2003, which was mandatory. Slovakia introduced a module about ICT into the structural survey in 2003, considering the model questionnaire developed by the OECD and Eurostat. This led to a few changes in the structural survey.

The Baltic states employed Eurostat methodology in their activities before joining the EU. CSB of Latvia carried out a survey on ICT usage in enterprises in 2002 (with reference year 2001) which was mainly based on Eurostat’s questionnaire and methodology. The Lithuanian ICT survey of 2002 focused on modules similar to those proposed by the Eurostat model questionnaire, and Estonia conducted an enterprise survey on ICT usage and e-commerce in 2003, following Eurostat’s recommendations.


Activities outside the European Union

While all major economies in the world have established mechanisms to monitor and measure the use of ICT by enterprises, the ways and instruments they use to do so are quite different. The approach taken in the USA in particular differs from the method adopted by European statistics. This makes a direct comparison of results quite difficult. Notwithstanding these differences, Canada, Australia and the USA can be regarded as pioneers in information society statistics.

30 "International Outlook on E-Business Developments", the follow-up study to this report, will present in more detail different approaches and results from Australia, Canada, Japan, Korea and the USA.
### Exhibit 2-1: ICT-related surveys conducted in major non-EU OECD Members

<table>
<thead>
<tr>
<th>Country</th>
<th>Title of survey</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Business Technology Survey</td>
<td>The broad data requirements are the penetration of various technologies, Internet use and web presence and the range of activities being conducted online, as well as a measure of the size of e-commerce in Australia.</td>
</tr>
<tr>
<td>Canada</td>
<td>Survey of Electronic Commerce and Technology 2002 (SECT)</td>
<td>Annual representative decision-maker survey among enterprises. This large scale, economy-wide survey of enterprises was first conducted in 1999.</td>
</tr>
<tr>
<td>Japan</td>
<td>2002 Communications Usage Trend Survey – Enterprises (CUTS)</td>
<td>Includes questions on the use of mail, telecommunications and broadcasting services by enterprises and on related trends. Results are used as background information for communication policy.</td>
</tr>
<tr>
<td>Japan</td>
<td>Usage on ICT Workplaces (ICT WP)</td>
<td>Prepare fundamental materials for accurately grasping the current information processing situation of companies (including trade associations, hereafter referred to as “companies”) using computers (including personal computers referred to as “PCs”) and for expanding measures to promote information processing and information industry.</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Business Practices Survey (BPS)</td>
<td>Firstly, the report looks at the adoption of IT systems by New Zealand firms. The intensity of IT use is explored, as well as the infrastructure that has been employed by businesses to facilitate the use of IT.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>ICT use in enterprises</td>
<td>Tracking ICT use and e-commerce activity in Swiss enterprises</td>
</tr>
<tr>
<td>USA</td>
<td>The USA chose an incremental approach, targeted to specific industries, starting with the retail trade industry, as opposed to economy-wide surveys.</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>Annual Retail Trade Survey (ARTS)</td>
<td>Provides annual estimates of total retail sales, e-commerce sales, purchases, end-of-year inventories, valuation methods and end-of-year accounts receivable.</td>
</tr>
<tr>
<td>USA</td>
<td>Annual Survey of Manufactures – Computer Network Use Supplement (ASM)</td>
<td>Survey of manufacturing plants</td>
</tr>
<tr>
<td>USA</td>
<td>Annual Trade Survey (ATS)</td>
<td>Covers all sectors except Agriculture, Forestry, Fishing and Hunting; schools and colleges; labour, political and religious organisations; public administration and private households</td>
</tr>
<tr>
<td>USA</td>
<td>Service Annual Survey (SAS)</td>
<td>Covers companies that primarily provide services to individuals, business and governments. Also covers the Transportation and Warehousing Sector. Coverage and detail have been expanded to include most personal, business, automotive, amusement and recreation, social, health and other professional services.</td>
</tr>
</tbody>
</table>

2.3 Research projects

The framework programmes (FP) for research and development in the European Union are an important platform for the development of information society indicators. Special sections of the various programmes within FP4, FP5 and FP6 have specifically been addressing statistical research and Indicator development. The research projects that have been carried out within this framework can be grouped into several categories, depending on their main objective. By analogy with the traditional categorisation of research, a basic distinction is to classify indicator projects as basic or applied research projects:

- "Basic research" on indicators: Projects that deal with general methodological issues concerning the definition of indicators. This includes, for instance, the consideration of quality criteria and conceptual frameworks. The NESIS project is presented here as an example of this type.
- "Applied research" on indicators: Projects that develop and pilot concrete indicators. Typically, in case the pilot proves successful, indicators are then recommended to official statistics for inclusion in regular surveys. The SIBIS and B2B Metrics projects are presented here as examples of this type.

The following section introduces a number of projects that have been (co-)funded by the European Union within the 5th and 6th Research Framework Programmes. They can be regarded as representative and relevant examples of indicator related research activities. The selection focuses on completed projects, as information for projects that have only begun is very limited. Exhibit 2-2 provides an overview. The projects that are most relevant for indicator development on ICT use among businesses are then briefly introduced in the form of a project ID-card. A comprehensive presentation of results by project would be out of the scope of this report.

Exhibit 2-2: EU Research Projects (completed) on ICT indicators

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Brief description</th>
<th>Completed in</th>
<th>Business</th>
<th>Citizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEI</td>
<td>KEI (&quot;Knowledge Economy Indicators: Development of Innovative and Reliable Indicator Systems&quot;) aims to develop and improve indicators for the knowledge economy, including the analysis of aggregation issues and the use of composite indicators. The project covers 30 European countries and six non-European countries. KEI reviews existing concepts and definitions of the knowledge-based economy and its key components. <a href="http://www.kei.publicstatistics.net/">http://www.kei.publicstatistics.net/</a></td>
<td>under way (until 03/2007)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>UNDERSTAND</td>
<td>UNDERSTAND (European Regions UNDER way towards STANDard indicators for benchmarking information society) is an Interreg IIc project, aiming to compare and evaluate regional development of the Information Society by defining and applying a set of common regional e-indicators on Internet usage by citizens and business, e-government and broadband infrastructure. <a href="http://www.understand-eu.net/">http://www.understand-eu.net/</a></td>
<td>under way</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

31 The overview focuses on projects from the 5th Framework Programme (FP), since many projects in the 6th FP are still under way. This makes it difficult to access results (mostly no documents yet published or only interim reports available).
### B2B Metrics
- Developed and piloted a questionnaire with innovative metrics for the measurement of diffusion and impacts of B2B e-commerce in specific sectors, with special attention to SME aspects.
- [http://www.b2b-metrics.de](http://www.b2b-metrics.de)

### NESIS
- New Economy Statistical Information System was designed to contribute to the continuing elaboration and evaluation of European benchmarking indicators, as successive phases of the Lisbon strategy are being implemented.
- [http://nesis.jrc.it](http://nesis.jrc.it)

### BISER
- Benchmarking the Information Society in European Regions: Definition, development and piloting of a set of statistical indicators for benchmarking the progress of European regions in respect of the eEurope Initiative and the emerging Information Society.
- [http://www.biser-eu.com](http://www.biser-eu.com)

### E-LIVING
- Life in a Digital Europe: Created and coordinated a set of pan-European longitudinal household panel studies to generate quantitative data on time-use and uptake of ICT, e-skills, environmental impacts and perceived quality of life.
- [http://www.eurescom.de/e-living/](http://www.eurescom.de/e-living/)

### SIBIS
- Statistical Indicators Benchmarking the Information Society: Piloting of innovative indicators on ICT uptake and use in households and businesses.
- [http://www.sibis-eu.org](http://www.sibis-eu.org)

### SEAMATE
- Socio-economic analysis and Macro-modelling of Adapting to Information Technologies in Europe: Focus on ICT impacts, both on enterprises (productivity, investments) and social impacts.
- [http://www.seamate.net/](http://www.seamate.net/)

### NewKind
- New Indicators for the Knowledge Based Economy: Developed indicators for assessing the significance of changes in the knowledge-base underlying economic, industrial and firm performance.
- [http://www.researchineurope.org/newkind/index.htm](http://www.researchineurope.org/newkind/index.htm)

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**SIBIS**

SIBIS (Statistical Indicators Benchmarking the Information Society) was a project in the "Information Society Technologies" Programme of the European Commission (Project No. IST-2000-26276). It ran from January 2001 to September 2003 with the objective of developing and introducing innovative information society indicators for benchmarking progress in the EU Member States. These indicators were piloted in 2 representative surveys (a general population survey and a decision-maker survey in enterprises) in EU Member States, Acceding and Candidate countries, Switzerland and the USA.

SIBIS was closely related to the eEurope and eEurope+ initiatives of the European Union and contributed to measuring the progress of eEurope actions in the above countries.
Exhibit 2-3: Project ID Card: SIBIS

<table>
<thead>
<tr>
<th>Start and end date</th>
<th>January 2001 – September 2003</th>
</tr>
</thead>
</table>
| Focus              | • Systematic stock-taking of existing information society indicators, grouped into 9 topics  
|                    | • Suggestion of new indicators (definition, rationale)  
|                    | • Piloting of indicators |
| Indicators         | • ICT adoption by households  
|                    | • Use of online services by citizens (this includes, in particular, e-learning, e-government, e-commerce)  
|                    | • Use of ICT by enterprises |
| Data sources       | Primary research: telephone / personal interviews with citizens and businesses.  
|                    | • General Population Survey (GPS):  
|                    |   o Apr. 2002: 11,832 interviews in EU-15, CH, USA  
|                    |   o Jan. 2003: 10,379 interviews in EU-10 (new MS), RO, BG  
|                    | • Decision-maker Survey (DMS) among businesses: Mar.-May 2003; 3,139 interviews in 7 EU Member States |
| More information   | Project website: www.sibis-eu.org (resources include the questionnaires used, Statistical Pocketbooks, Topic Reports) |

**B2B Metrics**

B2B Metrics was a research project in the "Information Society Technologies" Programme of the European Commission. It ran from January 2002 to July 2004. The objective was to develop innovative metrics for the measurement of diffusion and impacts of B2B e-commerce, with special attention to SME aspects.

Exhibit 2-4: Project ID Card: B2B Metrics

<table>
<thead>
<tr>
<th>Start and end date</th>
<th>January 2002 - July 2004</th>
</tr>
</thead>
</table>
| Focus              | • Analysis of impacts of electronic business between companies (B2B)  
|                    | • Development and piloting of innovative indicators |
| Indicators         | Indicators focus on four categories of business processes, which are considered to constitute the main pillars of B2B e-business:  
|                    | • Electronic procurement  
|                    | • Supply chain management  
|                    | • Customer relationship management  
|                    | • Collaborative e-development |
| Data sources       | • In-depth interviews with companies from the selected value networks (automotive industry, distribution, financial services, pharmaceutical industry, new media)  
|                    | • Pilot questionnaire survey (paper-based) within these sectors |
| More information   | Project website: www.b2b-metrics.de/intro.htm (resources include the questionnaires used, presentations and reports)  
|                    | Contact person: Mr. Hans Schedl, ifo Munich |

The project carried out oral and written pilot surveys in selected sectors (namely automotive industry, distribution, financial services, pharmaceutical industry, and new media), as a potential basis for subsequent surveys by national and European statistical offices. Special attention was paid to balancing informational needs of companies, policy and statistical...
offices. The pilot surveys were carried out in the countries of participating research organisations (Germany, Finland, France, Japan and the UK).

Surveys included companies from different "sectors" according to the official nomenclature of business activities, in order to reflect the structure of value networks. The working definition of "B2B applications" was: "B2B e-Business is the application of four (electronic) processes which tend to eliminate manual operations: e-Procurement, Supply chain management, Customer relationship management, Collaborative e-development. These cover early and more mature stages of development."

**NESIS**

NESIS, a 3-year project in the IST Programme (2001-2004), contributed to the continuing elaboration and evaluation of European benchmarking indicators, as successive phases of the Lisbon strategy unfold and are implemented. The activities were organised around four conceptual pillars that had emerged from the Lisbon strategy:

(a) The New Information Economy and eEurope;
(b) Productivity and Competitiveness in the New Information Economy;
(c) Human Investment in the New Information Economy;
(d) Social Inclusion in the New Information Economy.

### Exhibit 2-5: Project ID Card: NESIS

<table>
<thead>
<tr>
<th>Start and end date</th>
<th>2001 – 2004</th>
</tr>
</thead>
</table>
| Focus              | Stock-taking of existing indicators  
|                    | Basic research on indicator requirements for policy |
| Indicators         | The New Information Economy and eEurope  
|                    | Productivity and Competitiveness in the New Information Economy,  
|                    | Human Investment in the New Information Economy  
|                    | Social Inclusion in the New Information Economy. |
| Data sources       | Pilot studies on a small scale. Primary data collection was not a focus of the project. |
| More information   | Project website: [http://nesis.jrc.it/](http://nesis.jrc.it/) |

NESIS tried to cluster indicator activities of the current research projects under SINE (Statistical Indicators of the New Economy) of the IST Programme, and undertook a limited number of statistical pilot case studies. The project set up an Indicators Development Working Group (IDWG). The IDWG served as an advisory group for indicator clustering and for dissemination of best practice.

NESIS can be classified as basic research on indicators rather than as an applied research project. The objective was mainly to develop conceptual and analytical underpinnings for indicators in the broad sense than to come up with concrete suggestions of new indicators. For example, research carried out within pillar 2 (productivity and competitiveness) had the following indicator-related objectives: stocktaking on existing attempts to conceptualise the new economy, re-conceptualisation of indicators for the new economy, development of appraisal criteria for indicator quality management systems, and the conceptual appraisal of existing and imminently available EU indicators. (cf. [http://nesis.jrc.it/](http://nesis.jrc.it/), March 2005).

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32 Companies from a given sector may have important business relations with suppliers or customers from other sectors.
NewKind

NewKind started from the assumption that economic, industrial and firm performance has an underlying knowledge-base. The objective of the project was to develop indicators for assessing the significance of changes in this knowledge-base. The project tried to connect knowledge-based indicators to indicators of performance, in order to draw policy relevant conclusions about the nature and extent of knowledge-based developments on economic performance. New knowledge-related indicators of economic activity were designed to assess the accumulation of intangible capital across European economies, the emergence of electronic commerce, and the changing structure of the knowledge-base of firms. The main target group of this exercise were policy-makers.

NewKind conducted firm-level studies in the insurance, pharmaceutical and the tyre industry. The insurance industry was selected as an information intensive sector in which information flows constitute the main business. The pharmaceuticals industry was selected as a science-based sector that provides a strong basis for knowledge-related indicators. The tyre industry was selected because it was found to be increasingly reliant upon a scientific and technological knowledge base, which also provided an adequate test-bed for the new measures developed.

The result that emerged from the three sector case studies was that a firm’s knowledge base cannot be framed as a generic concept across industries and not even across individual companies. Rather, attention needs to be paid to the variety of knowledge bases on which firms in a wide range of industries rely. While most firms in the industries studied are involved in complex networks of suppliers of specialised knowledge, the firms within these networks were definitely not all alike.

Exhibit 2-6: Project ID Card: NewKind

<table>
<thead>
<tr>
<th>Start and end date</th>
<th>1999 - 2002</th>
</tr>
</thead>
</table>
| Focus              | - Conceptualise the knowledge-based economy  
                    - Link knowledge-based indicators to indicators of business performance |
| Indicators         | - Knowledge-related indicators of economic activity |
| Data sources       | - Firm-level studies (case studies) in insurance companies, the pharmaceutical industry and the tyre industry. Combination of interview and questionnaire techniques.  
                    - Secondary sources:  
                      o For the tyre industry: original data set built upon Derwent Patents databases, and original database built upon the annual J.D. Power Consumer Survey Ranking  
                      o For the pharmaceutical industry in Spain: original data set on the entire population of Spanish domestic firms (patents, publications, sales); knowledge bases of the world’s largest pharmaceutical groups. |
2.4 Special studies and commercial market research

Special studies on ICT deployment and use in enterprises are now abundant. When the e-Business W@tch was launched, however, there was a lack of empirical evidence on e-business activity in different sectors, and particularly in small and medium-sized enterprises. Moreover, some of the studies and market reports issued during the high-time of the new economy were either biased or "hyped" in the sense that they were based on wrong assumptions about future development. Currently available studies include commercial, multi-client studies from market research organizations such as IDC, Gartner or Forrester, as well as regular studies and yearbooks from organizations and consortia such as EITO. In this study, two examples are highlighted since they have gained significant attention by policy and are frequently quoted in research. The first case, EITO Yearbook, is a leading example for primary compilation of industry statistics; the second one, Global Information Technology Report, is an example of how to construct sophisticated compound indicators on ICT from existing sources.

2.4.1 EITO Report

The European Information Technology Observatory (EITO) is a rather unique European initiative and consortium focusing on the provision of macro market data on the ICT industries. Members are Deutsche Messe (CeBIT), Smau, SIMO and Bitkom Servicegesellschaft. EITO is supported by the European Commission and the OECD and has as sponsors Systems, Telecom Italia, Sony Europe, Enterprise Digital Architects and KPMG. EITO market data are provided by the EITO Task Force in co-operation with IDC, Strategy Analytics and GfK.

EITO publishes an annual report, the "Yearbook", which compiles data and analysis about the ICT industries in Europe. Statistics cover the Western and Eastern European IT and telecommunications markets, including detailed figures by country and by market segment. The EITO report also includes special studies on topics of particular interest to its constituencies and an extensive overview of the latest technological developments. Target groups of the EITO Yearbook are the industry (notably the ICT and media industries), the scientific, research and policy-making communities and the media.

Main results 2005

The EITO Yearbook 2005 reports that ICT markets have "emerged from the tunnel of the deep crisis of 2001-2003" and identifies the following trends:

- Growth of worldwide markets for ICT continues, reaching 4.3% in 2005 and 4.8% in 2006, definitely leaving the crisis of 2001-2003 behind
- Strong growth in the new EU Member States, contributing to the fact that the European ICT market is expanding faster in 2004 and 2005 than the US and the Japanese markets
- Forecast: Information Technology (IT) growth in the European Union increases from 3% in 2004 to 4.5% in 2005 and 2006
- Broadband drives growth in EU telecommunications


Methodology

Data and forecasts presented in Part Three of the annual EITO reports ("Statistical Outlook") are jointly prepared by IDC and the EITO Task Force. The introduction to this chapter states that "ICT market size and growth trends by country and technology reflect the opinion of both the EITO Task Force and IDC" (EITO 2005, p. 202). The underlying conceptual framework for calculating data and growth trends has been developed by IDC.

The relevant markets for which EITO presents data are the "markets for telecommunications and information technology products and services, including substantial elements of the associated market for office automation products". Market data are expressed in end-user spending. Thus, the performance of the primary vendors is critical. EITO states that research results are "cross-checked against a continuous programme of end-user interviews and distribution channel monitoring". Market data about mobile phone sets are an exception to this approach. Here, manufacturer revenues are used, because end-user prices are so much dependant on different incentive policies by network providers (for concluding contracts) that comparisons between operators and across countries are no longer possible.

However, the methodology for estimating the overall market sizes for various segments of the telecommunications and ICT markets, for assessing growth rates and making forecasts is not explained in detail. Data on trade-flows are collected and matched "as closely as possible to market-oriented segmentation", but there is no information about the sources or framework used to compile the market data. The report states that "market share statistics are based upon aggregations of IDC research" (EITO 2005, p. 280). Results that are derived from this approach occasionally show discrepancies with official statistics on the ICT sector such as those ones published by Eurostat and the OECD.

The chapter on definitions (Part Three "Statistical outlook", chapter 12) explains how the ICT markets have been segmented. The market segmentation used in EITO Reports since 2001 defines the "total ICT market" as the aggregate of four segments:

- ICT equipment (including computer hardware, end-user communications equipment, office equipment, and datacom and network equipment);
- Software products;
- IT services;
- Carrier services.

In past editions of the EITO Report (up to 2000), segments were slightly different, making up two main categories – "telecommunications" and the "IT industry". These two main segments of the overall industry still apply, however: figures for "total telecommunications" and "total IT" are still included in the tables of the recent reports to maintain consistency in the presentation. The "definitions" chapter includes clear definitions for each sub-segment, explicitly acknowledging that convergence makes it increasingly difficult to draw clear borderlines between the various IT and telecommunications markets.

In spite of clearly defining how the ICT industries have been segmented, critical users of the EITO Reports may still feel that there is a certain lack of transparency regarding details of the methodology used to collect the industry data. However, this does not do any harm to the strong position, credibility and acceptance of EITO as an authoritative source (or even "the" source) for data on European ICT markets. The high profile of EITO is secured by the leverage of the powerful consortium which is bringing together important players from industry, policy and market research.

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Comparison of EITO to e-Business W@tch

Although both initiatives focus on data collection and analysis of ICT deployment, the approaches are quite different and complementary to each other, at least as far as the statistical part is concerned:

- **e-Business W@tch** uses representative surveys among firms to collect data, focusing on ICT use in enterprises from different sectors.
- EITO, on the other hand, collects supply-side data from ICT providers to estimate the total volume of the ICT market.

What the two initiatives have in common is that they aim to integrate the statistics with a qualitative analysis of market trends and business implications. In this context, Part Two of the annual EITO Reports features special studies and analyses about the use of ICT, while the (statistical) Part Three focuses on the ICT industries (supply-side) and not on the use.

2.4.2 Global Information Technology Report 2003-2004

The Global Information Technology Report (GITR) is a special project within the framework of the Global Competitiveness Programme. It is the result of a collaboration between the World Economic Forum, the World Bank, and INSEAD. At the core of the GITR is the "Networked Readiness Index" (NRI), which is defined as "a nation's or community's degree of preparation to participate in and benefit from information and communication technology (ICT) developments" (p. 3).

The NRI is a highly aggregated index, based on a large number of existing variables from different sources. In total, 91 component variables were chosen on the basis of their qualitative relevance to the framework. Data are drawn from secondary sources, as well as from a survey (opinion poll) of company executives from the countries covered, asking them to rank their opinions on the state of affairs in their country on a scale from 1-7.

The variables are divided into three categories: "environment" for ICT, the "readiness" of key stakeholders to benefit from ICT, and finally the level of "usage" of ICT. The first category is, in turn, distinguished into market, political and regulatory and infrastructure environment, while component indexes of "readiness" and "usage" are both broken down into the three main stakeholder categories of society: individuals, businesses and governments (cf. Exhibit 2-7).

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36 e-Business W@tch has contributed to (Part Two of) EITO Report 2003, with a special analysis on ‘The adoption of e-business by European enterprises: Uptake and economic impact by sector’.

37 The Global Competitiveness Programme (GCP) is part of the World Economic Forum, which is based in Geneva, Switzerland. Within the Forum, the Programme is part of the Centre for Strategic Insight. The GCP team focuses on two main activities: reports and workshops. The Programme's goal is to help nations improve their economies by publishing its competitiveness research and leading workshops about national and regional competitiveness. Cf. http://www.weforum.org

38 INSEAD (www.insead.edu) is a widely recognised as one of the world's top-tier business schools, with campuses in Asia (Singapore) and Europe (Fontainebleau).

39 This approach (the survey of business leaders) is somewhat controversial, as it leads to proprietary data that are not accessible to external users, and has caused political tensions. It appears that the responding behaviour differs between respondents when it comes to assessing their own country. A cultural bias cannot be excluded in this context (there may be a bias towards giving positive answers about the situation in a country, but also a bias towards avoiding being "too friendly" to one's own country).
The GITR 2003/04 presents the NRI values for 102 countries. Thus, the report allows benchmarking of the performance of key economies in various dimensions, as specified by the NRI framework (benchmarking is possible for each component index and sub-index).

Methodology

The calculation of the NRI basically consists of the following steps:

- Selecting qualitatively relevant variables from available sources
- Estimating missing data (e.g. for countries or for the relevant year)
- Statistical analysis to ensure statistical significance
- Calculating the index by averaging the normalized data.

Data selection: NRI uses two types of data: "soft data", which are subjective data gathered from questionnaires (managed by the World Economic Forum as part of their research for the Global Competitiveness Report), and "hard data", which are driven by statistics collected by international multilateral agencies (such as the World Bank and ITU). The soft data are critical in depicting the opinion of decision-makers and influencers who are intimately familiar with a nation’s economy and ICT usage. On the other hand, the hard data capture fundamental elements related to the development of infrastructure, human capital and ICT.

Data estimation: Despite the effort to collect data from all major international sources, it is necessary to cope with incomplete sets of data for the countries under consideration. Statistical procedures are used to estimate missing data, mainly regression and clustering techniques.
Statistical analysis: Once potential variables have been identified and selected, a comprehensive statistical analysis is being conducted. Correlation and factor analyses are conducted to determine interrelationships amongst variables and, if necessary, to drop variables. The remaining variables are then classified along the lines of the NRI framework.

Calculating the Index: In order to calculate the index, data are transformed on a scale of 1 to 7, so that each component indicator has an equal weight. Next, each of the sub-indexes is computed as the mathematical average of the indicators composing it. The same approach is then used to calculate the component indexes, averaging the sub-indexes. Finally, the NRI is computed as an average of the three component indexes.

Comparison of the GITR to e-Business W@tch

The approach used to calculate the Networked Readiness Index is very similar to the approach used by e-Business W@tch to construct the e-Business Scoreboard and the resulting e-Maturity Index. Although the scope of two Indexes (NRI and e-Maturity Index) in terms of the number of underlying component indicators and their sources is not comparable, the approach to aggregate single indicators into an index by grouping them into a hierarchical framework of various dimensions is the same.

However, the two initiatives have different objectives. While e-Business W@tch focuses on collecting new, primary data (through the e-Business Surveys and case studies), GITR focuses on adding value to existing information by selecting, harmonising and aggregating data from different sources.
3 Considerations on compound indicators

3.1 General considerations

Compound indicators (or composite indicators) can be defined as a mathematical combination (or aggregation) of a set of indicators. A special feature is that the combination, i.e. the selection of component indicators, is to some extent arbitrary, as these components are only loosely associated with each other. This feature of compound indicators (CIs) is described in a JRC report (p. 5)\(^{41}\), as follows: "Composite indicators are based on sub-indicators that have no common meaningful unit of measurement and there is no obvious way of weighting these sub-indicators."\(^{42}\) In principle, however, the objective of using compound indicators is not different to the one for simple indicators. Indicators, whether simple or compound, are "something that provides a clue to a matter of larger significance or makes perceptible a trend or phenomenon that is not immediately detectable" (Hammond at al. 1995).

The Controversy about Compound Indicators

"Composite indicators are confusing entities whereby apples and pears are added up in the absence of a formal model or justification."

"Composite indicators are a way of distilling reality into a manageable form."

(Euroabstracts 2004)


CIs have experienced a surge in popularity, mainly because of their promise to capture and reduce complexity of multi-dimensional concepts, such as education, welfare, or, in the framework of the e-Business W@tch, electronic business. However, there are conflicting views on the merits of these indicators, particularly if they are highly aggregated. Criticism is increasing quite at the same pace as the use of compound indicators in policy and in public life has become more common. (cf. Saltelli et al. 2004)

CIs serve two purposes. First, they are an instrument to compare the situation among units of observations (e.g., countries) at a certain point of time. Second, they can be an instrument to monitor developments and changes over time. This implies that the value of a CI increases significantly once the index has been established and can be calculated in regular intervals, provided that changes (e.g. from year to year) are statistically valid. Otherwise, they are a nice tool for benchmarking, but do not allow monitoring subsequent developments and changes after the first point of measurement.


\(^{42}\) Sub-indicators, however, can have a "common meaningful unit of measurement", for example indicators on "fixed mainlines" and "cell phones" per capita.
A Guide to Indicators on ICT Use by Firms

Exhibit 3-1: Compound indicators (CI) – promises and risks

<table>
<thead>
<tr>
<th>Promises of CIs</th>
<th>Risks of CIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CIs capture complex, multi-dimensional concepts by reducing their complexity: They provide the &quot;big picture&quot;</td>
<td>• Misleading, non-robust policy messages: CIs let policy-makers take &quot;pseudo-informed&quot; decisions.</td>
</tr>
<tr>
<td>• CIs are a powerful instrument for visualization</td>
<td>• Over-aggregation: CI become meaningless if compound indicators are too heterogeneous</td>
</tr>
<tr>
<td>• CIs are an instrument to trigger public discussion (&quot;Why are the figures as they are?&quot;)</td>
<td>• &quot;Populism&quot;: CIs create simplistic discussions (and possibly policy decisions)</td>
</tr>
<tr>
<td>• CIs facilitate benchmarking exercises</td>
<td>• Follow-up costs: CIs increase quantity of data needed (any gap in one of the component indicators makes aggregation impossible)</td>
</tr>
</tbody>
</table>

Underlying assumptions

("aggregators' view")

| • It is possible to compute a meaningful "bottom line" from different component data. |
| • CIs are a proven method and indispensable in data-intensive sectors, particularly in financial services (e.g. stock Indices). |

Underlying assumptions

("non-aggregators' view")

| • Statistical representation of the reality should stop at the point where an appropriate set of (single) indicators has been created. |
| • Arbitrariness in the weighting of component indicators; "weighting", however, is inevitable; even using equal weights for each component indicators is a form of weighting. |

Source: Adapted from Saisana / Tarantola (2002) and OECD (2005)

Recommended steps in constructing compound indicators

At a workshop on "Composite Indicators of Country Performance" (OECD / JRC 2004), it was concluded that the quality of composite indicators depends on three main aspects:

• Basic data: the quality of the underlying data used to construct the component indicators

• Aggregation procedures: the quality of procedures used to compute the compound indicators

• Communication of results: the quality of approaches used to explain and disseminate the compound indicators.

At the same time that this report was being prepared, the OECD and the Joint Research Centre of the European Commission were working on a Handbook of compound indicators, which is intended to assist both the users and builders of composite indicators.

For constructing compound indicators, eight steps are proposed (cf. Exhibit 3-2). In the same exhibit, the e-Business Scoreboard by e-Business W@tch is used as an example to briefly illustrate whether and how each step has been accomplished.

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**Exhibit 3-2: Recommended steps in constructing compound indicators: a practical example**

<table>
<thead>
<tr>
<th>No.</th>
<th>Step (according to the OECD / JRC Handbook on CIs)</th>
<th>E-Maturity Index (E-Business Scoreboard 2004) by e-Business W@tch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Theoretical framework</td>
<td>Definition of &quot;e-business&quot; according to OECD definition, and definition of the scope of the study. Subsequently, translation of this conceptual framework into a survey questionnaire which is organised in several modules. For constructing the Index, a simplified model of e-business covering four dimensions has been specified: ICT infrastructure, internal processes, supply-side applications, customer-facing applications.</td>
</tr>
<tr>
<td>2</td>
<td>Data selection</td>
<td>Selection of component indicators from the survey questionnaire for each of the four dimensions of the index.</td>
</tr>
<tr>
<td>3</td>
<td>Multivariate analysis of data</td>
<td>This step was not carried out for the E-Business Scoreboard.</td>
</tr>
<tr>
<td>4</td>
<td>Normalisation</td>
<td>Normalisation of the percentage values for each of the 16 component indicators.</td>
</tr>
<tr>
<td>5</td>
<td>Weighting and aggregation</td>
<td>Decision not to use different weights for component indicators.</td>
</tr>
<tr>
<td>6</td>
<td>Robustness and sensitivity</td>
<td>No tests carried out.</td>
</tr>
<tr>
<td>7</td>
<td>Explanatory power</td>
<td>The Scoreboard has been well accepted by users, as it intuitively visualises sectoral e-business maturity. The four dimensions of the Index adequately represent various aspects of e-business activity.</td>
</tr>
<tr>
<td>8</td>
<td>Back to the real data</td>
<td>Cross-check of the results (overall results and for the four dimensions) with the qualitative analysis carried out in the context of e-Business Sector Studies. The Scoreboard index reflects very well the overall assessment. There is strong evidence that the condensed presentation of sectoral e-business intensity as shown by the E-Business Scoreboard is a &quot;true&quot; picture of the relative importance of ICT and e-business in a sector compared to others. Results are now validated by the new e-Business Survey (2005).</td>
</tr>
</tbody>
</table>

Source: OECD / JRC [http://farmweb.jrc.cec.eu.int/ci/FAQ.htm](http://farmweb.jrc.cec.eu.int/ci/FAQ.htm); practical example by e-Business W@tch (2005)
3.2 Quality assessment of compound indicators – a practical guideline

In the academic and scientific debate of indicators, requirements for high-quality compound indicators (CIs) are stressed, along with the need for continuous assessment of that quality. Significant efforts have been made to develop a quality framework for CIs. Several organisations (including Statistics Canada, Statistics Sweden, Eurostat, International Monetary Fund) have been working towards the identification of various dimensions of quality for statistical products (OECD 2005, Part I, p. 30).

**Example:**

**Towards a quality framework for compound indicators – the Eurostat framework**

Eurostat proposes a quality framework for statistical outputs. It focuses on statistical outputs as viewed by users, and works its way back to the underlying processes only where the outputs do not yield a direct measurement. The framework is based on seven dimensions, which try to answer the following questions:

1) Relevance: are the data what the user expects?
2) Accuracy: are the figures reliable?
3) Comparability: are the data in all necessary respects comparable across countries?
4) Credibility: are the figures credible and can they be replicated?
5) Coherence: are the data coherent with other data?
6) Timeliness and punctuality: does the user receive the data in time and according to pre-established dates?
7) Accessibility and clarity: is the figure accessible and understandable?

Given the institutional set-up of the European Statistical System, the main aim of the Eurostat quality approach is to ensure that certain standards are met in various aspects of statistical production processes carried out by national statistical agencies and by Eurostat itself.

Source: OECD / JRC 2005, p. 31

In practice, however, advisers, politicians and other decision-makers often have to rely on the statistical data that are available. They have to accept that scarce resources (e.g., money, human resources) put manifold restrictions on the collection of new data, as well as on an in-depth analysis and quality-control of the data available. This implies serious restrictions in policy areas where data are difficult to obtain and calls for a pragmatic approach, possibly compromising the expectations on statistical quality.

Against this background, a quick and easy-to-use approach to a basic quality assessment of compound indicators could therefore be of much use. Such guidelines should answer two important questions:

- What are the key quality factors for a given compound indicator?
- How can that quality be measured?

Based on the general considerations given in chapter 3.1, in particular on the list of promises and risks and on the recommended steps in constructing compound indicators, four quality issues could be addressed as a kind of checklist when working with compound indicators.
3.2.1 Four quality issues for compound indicators

1. Transparency of compound indicator construction

A transparent construction procedure of the CI is the basic requirement for quality assessment; it must be comprehensible and reproducible, also allowing for the disaggregation of the CI.

- First of all, the set of sub-indicators used for the CI must be given, along with the sources and the spatial and temporal scope of each indicator. The importance of the scopes lies in the fact that similar scopes are crucial for the comparability of the data. For example it would be difficult to compare indicator A for country 1 measured in 2001 to the same indicator measured for country 2 in 2004. The same holds true for the spatial scope.

- Second, the computation methodology or algorithm must also be given, as different methodologies impose different restrictions on the data. A simple sum of sub-indicator rankings, for example, means the loss of absolute level information, whereas the calculation of a standardized score based on the difference between a single indicator value and the indicator's mean divided by the standard error may lead to an overweighting of extreme values.

- Third, the weighting procedure used on the sub-indicators must also be made transparent. Data-weighting must be used with care, as it is a highly controversial issue. The weighting procedure must be reproducible and concordant with statistical standards. The weights must correspond to the basic assumptions or theoretical framework used for the CI’s creation.

2. Quality of data

A compound indicator is based on a set of sub-indicators, which are themselves based on statistical data (e.g. from surveys, national accounting, etc.) – and, obviously, the quality of these data is crucial for the quality of the CI itself. The aggregation process not only condenses the data but also aggravates existing errors as those, too, are added up, making the CI results susceptible to small changes. In this context:

- Firstly, the reliability of the data sources should be considered. In case of data coming from official sources (e.g. EUROSTAT, UNSTAT, OECD, NSIs, etc.) one can generally assume a high quality in terms of sampling, representativeness, analysis, etc. Problems might only be caused by missing data, especially when a large group of countries and/or a large time-span has to be covered. There are several ways to deal with gaps in the data, such as mean substitution, correlation results or time series which can be used, but will have an effect on the calculated results.

- Secondly, there might be problems concerning different methodologies, especially when using data from national statistical institutes. A well-known example is the calculation of the unemployment rate, which not only varies between countries but also between years in the same country, including or excluding certain sub-groups from the overall group of the unemployed (e.g. training participants). Obviously, those problems are next to impossible to cope with and in most cases will simply have be to accepted and denoted if they occur.

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44 For further information on the specifics of certain CI construction methodologies, cf. JRC, 2002.

45 This requirement corresponds to the quality criteria No. 2 ("accuracy") and No. 3 ("comparability") in the Eurostat framework as featured in the introduction to this chapter, cf. OECD / JRC 2005, p. 31.
3. Appropriateness of the underlying model

It has been pointed out before that the underlying model of a CI has a strong influence on all steps of its construction and on the calculated results. It is therefore of high importance that this model or theoretical framework is not only made explicit but also corresponds to the needs and purposes of those that use the CI to reach practical conclusions.

A basic form of a CI model can be a political idea or goal. Sub-indicators will then be selected which are relevant with regards to that idea, e.g. by measuring its feasibility, prerequisites or outcomes. As the JRC pointed out, the process of sub-indicator selection is not a fully objective one (cf. JRC 2002), as “relevance” in itself is a concept with a subjective share. A full match of the given CI model and the practitioner’s goal will in many cases not be reached but is also not a necessary condition. Slight or medium deviances can in many cases either be tolerated or alleviated by supplementing additional indicators.

Supplementing does not necessarily mean a re-calculation of the CI including the additional indicator; it can also be done by adding a descriptive analysis of the supplement (e.g. cross-tabulation, frequency counts) to the overall data analysis and the conclusions drawn from it.

4. The holistic viewpoint

The last quality issue is again in a way related to the theoretical framework and the questions of sub-indicator selection. As a CI means a condensation of a large data-set into a single value and therefore a reduction of information, it is so much more important that the data put into the calculation are selected from a holistic viewpoint.

An example: a CI measuring the development of the knowledge economy in Europe must take into account the prerequisites (or readiness-factors) for that kind of economy as well as the outcomes (or impacts). So measuring the use of e-commerce without looking for general Internet use or a basic readiness-factor such as the educational level would mean to leave out important influence factors. The CI would fail to explain the reasons for a certain outcome: high or low use of e-commerce due to a high or low level of internet use and a high or low digital divide.

Second, the CI should take both the macro- and the micro-level into account, e.g. by supplementing measures of group-performance (such as GDP) with measures of individual performance (e.g. labour-productivity per head) and distributional measures (such as the GINI coefficient\textsuperscript{46}), again providing a more holistic insight. The importance of such supplements has been pointed out, for example, by Anand and Sen in the context of the Human Development Index\textsuperscript{47}. Again the shortcoming of a CI in terms of the holistic viewpoint can be counteracted by an additional descriptive analysis of the necessary supplements rather than by re-calculating the whole CI.

It is also important in this context that data other than those used in the construction of the CI should be used to analyse its changes. External variables can help to explain the underlying causes.

\textsuperscript{46} The Gini coefficient is a measure of inequality developed by the Italian statistician Corrado Gini and published in his 1912 paper "Variabilità e mutabilità". It is often used to measure income inequality, but can also be used to measure any form of uneven distribution. The Gini coefficient can take a value from 0 and 1, where 0 corresponds with perfect equality (e.g. where everyone has the same income) and 1 corresponds with perfect inequality (e.g. where one person has all the income, and everyone else has zero income). Cf. \url{http://en.wikipedia.org}

\textsuperscript{47} Cf. Anand & Sen, Human Development Index: Methodology and Measurement, 1994. The index was created for the United Nations Development Programme (UNDP). The authors refer, among other things, to the Difference Principle formulated by John Rawls.
3.2.2 A practical checklist for CI quality assessment

To ease the practical procedure of quality assessment for CIs, the quality issues described above are now given as a short checklist of four questions, grouped as questions about the form and about the content of a CI. Each of these questions is followed by one to three sub-questions and complemented with short clues about possible coping strategies for common problems.

Formal questions

Question 1: Has the CI’s construction been made transparent?
- Are the sub-indicators given?
- Is the computation or algorithm known?
- If the sub-indicators have been weighted, is the weighting procedure reproducible and according to standards?

If one of the questions is answered with a “No”, the general quality of the compound indicator is in doubt. Accepting a non-transparent CI means relying entirely on the issuing organisation. If that kind of trust seems inappropriate one can either discard the CI or try a descriptive re-analysis of the sub-indicators (e.g. in the way of simple cross-tabulations or frequency counts) and compare those results with the results of the CI. Are the results basically the same or do they differ clearly? Major differences might point to a doubtable index construction. Results from the index should be considered with care or not at all.

Question 2: Are the sub-indicators reliable in terms of...
- ...data sources?
- ...spatial and temporal comparability?

Official sources such as EUROSTAT, UNSTAT, the OECD or the NSIs can be considered reliable in terms of sampling, representativeness, analysis, etc. In case of fragmentary coverage (missing data), the CI’s results should be considered with some care in the uncovered areas. The use of coping strategies such as mean substitution, correlation results or time series should be made explicit.

Questions about the content

Question 3: What is the CI’s underlying model or theoretical framework?
- Is the model made explicit?
- How has the model been put into practice?
- Are both model and practical implementation acceptable and/or in accordance with the purpose of the analysis?

The model is the underlying conceptual framework for the CI. A rationale should be provided as to why the CI can be expected to provide an adequate, condensed view on developments that are to be measured. In the context of electronic business, for example, the model should state the definition of e-business, the main dimensions that are considered as relevant, and how these can be translated into variables. It should also address the difficulties and challenges that have been experienced.

Question 4: Does the index take a holistic position?
- Are prerequisites (or readiness-factors) considered as well as outcomes (or impacts)?
- Are both the macro- and the micro-level taken into account?

If one or more of these (sub-)questions to question 4 are answered with a “No”, one should consider supplementing the index with other data of equal spatial and temporal scope.
3.3 Examples of compound indicators

3.3.1 Examples from various policy areas

The number of compound indicators is abundant, even if only indicators on ICT related issues are considered. Any selection of examples in the context of this report can only represent a small fraction of indicators that are described and used in literature. An excellent, authoritative source that lists and explains relevant compound indicators is the "Composite Indicator" website by the European Commission's JRC.\[^{48}\] Compound indicators are grouped by subject (environment, society, economy, innovation/technology/information, globalisation). A few CIs from this list are presented here as examples (see Box: "GDP, HDI and ESI – different perspectives on economic development", and Exhibit 3-3).

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**Compound Indicator examples:**

**GDP, HDI and ESI – different perspectives on economic development**

**Gross Domestic Product** (GDP), which represents the total value of goods and services produced by economy over a certain period of time, is a very robust index, but has several shortcomings if used as an index for sustainable economic and social development. In the absence of better measures, however, GDP is often used as a proxy in such contexts.

To compensate for these shortcomings, several alternative indices which capture the social and environmental dimensions of prosperity, rather than just focusing on aggregate production, have been proposed and calculated. Two notable examples are the HDI and the ESI.

The United Nations has developed the **Human Development Index** (HDI) and published results for more than ten years now. HDI is a composite index that measures average achievements of a country in three basic aspects of human development: longevity, knowledge, and a decent standard of living. HDI serves as an acceptable benchmark for assessing human development particularly in emerging economies, even if the UN is not universally accepted as an "arbiter" on what is and what is not human development.

World Economic Forum publishes the **Environmental Sustainability Index** (ESI). ESI is a measure of the overall progress towards environmental sustainability, developed for 142 countries. Scores are based upon a set of 20 core indicators, each of which combines two to eight variables for a total of 68 underlying variables.

However, these indices (as well as other innovative approaches to measure economic development from a broader perspective) still have little relevance in policy-making compared to GDP, which is such a powerful index that it more or less directly defines the level of economic achievement.

Source: Moldan, Bedřich et al. (2004): Composite Indicators of Environmental Sustainability.

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**Exhibit 3-3: Compound indicators (examples)**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Compound indicator</th>
<th>Provider</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy</td>
<td>Big Mac Index</td>
<td>The Economist Intelligence Unit / Pyramid Research</td>
<td>Light-hearted guide to whether currencies are at their &quot;correct&quot; exchange rate. Index is based on the theory of purchasing-power parity (PPP). The simple &quot;basket&quot; is a McDonald's &quot;Big Mac&quot;, which is produced in about 120 countries.</td>
</tr>
<tr>
<td>Business climate indicator</td>
<td>European Commission</td>
<td></td>
<td>It was developed to better indicate the business cycle in the European area as a whole.</td>
</tr>
<tr>
<td>Composite Leading Indicators</td>
<td>OECD</td>
<td></td>
<td>The objective was to create a cyclical business indicator with better forecasting and tracking qualities than any of its individual components.</td>
</tr>
<tr>
<td>&quot;Doing Business&quot; indicators</td>
<td>World Bank</td>
<td></td>
<td>A database that provides indicators of the cost of doing business by identifying specific regulations that constrain business investment, productivity, and growth.</td>
</tr>
<tr>
<td>e-Business Index</td>
<td>European Commission</td>
<td></td>
<td>Assesses the propensity of European firms to adopt and use ICT.</td>
</tr>
<tr>
<td>e-business-readiness rankings</td>
<td>Economist</td>
<td></td>
<td>Measure for the relative preparedness of the world's main markets to benefit from e-business.</td>
</tr>
<tr>
<td>Economic Competitiveness Index</td>
<td>Institute for Management Development</td>
<td></td>
<td>Analyses and ranks the ability of nations to provide an environment that sustains the competitiveness of enterprises.</td>
</tr>
<tr>
<td>Index of sustainable and economic welfare</td>
<td>CES and NEF</td>
<td></td>
<td>Index showing the &quot;proportion of economic activity that delivers welfare to people.&quot;</td>
</tr>
<tr>
<td>Innovation, Technology, Information</td>
<td>E-Government Rankings</td>
<td>World Markets Research Centre</td>
<td>Based on a detailed analysis of 2,288 government websites in 196 nations.</td>
</tr>
<tr>
<td>General Indicator of Science and Technology</td>
<td>NISTEP, Japan</td>
<td></td>
<td>Combines major trends in Japan's science and technology activities and enables international comparisons and time-series analysis.</td>
</tr>
<tr>
<td>Information &amp; Communication Technologies</td>
<td>Fagerberg</td>
<td></td>
<td>Provides an overall picture of a country's situation regarding the development and application of ICT.</td>
</tr>
<tr>
<td>Innovative Capacity Index</td>
<td>Porter and Stern</td>
<td></td>
<td>Highlights resource commitments and policy choices that most affect national innovative capacity in the long run.</td>
</tr>
<tr>
<td>Investment / performance in the knowledge based economy</td>
<td>European Commission</td>
<td></td>
<td>Measures EU Member States’ investments / performance in the knowledge-based economy</td>
</tr>
<tr>
<td>Summary Innovation Index</td>
<td>European Commission</td>
<td></td>
<td>Describes the strengths and weaknesses of Member States and European convergence concerning innovative ability.</td>
</tr>
<tr>
<td>Technology Achievement Index</td>
<td>United Nations</td>
<td></td>
<td>Captures the performance of countries in creating and diffusing technology and in building a human skills base.</td>
</tr>
<tr>
<td>Networked Readiness Index</td>
<td>INSEAD / World Economic Forum</td>
<td></td>
<td>Defined as the degree to which a community is prepared to participate in the networked world as well as its potential to do so in the future.</td>
</tr>
</tbody>
</table>

Source: OECD / JRC: Composite Indicators - an information server on composite indicators
3.3.2 The e-Business Index of eEurope 2005

Efforts to reduce complexity through indices have also been made in the area of electronic business, which constitutes a multi-dimensional concept in itself. A recent suggestion in this context, albeit a rather simple one, was the e-Business Scoreboard which e-Business Watch presented in 2004 (cf. e-Business Watch, Pocketbook 2004), along with its resulting e-Maturity index. The latter was introduced in 2003 as a proxy to the "e-Business Index" which was developed in the context of eEurope 2005.

This chapter focuses on the "e-Business Index" which was developed in the context of eEurope 2005. The eEurope 2005 Action Plan\(^\text{49}\), endorsed by the Council Resolution of 28 January 2003\(^\text{50}\) calls for a benchmarking of the target that "by 2005, Europe should have (…) a dynamic e-business environment", specifying that "e-business comprises both e-commerce (buying and selling on-line) and restructuring of business processes to make best use of digital technologies". It proposes general guidelines for the benchmarking exercise and sets out a number of indicators to monitor progress in the implementation of the eEurope 2005 Action Plan. Against this background, DG Enterprise proposed and developed with Eurostat\(^\text{51}\), in late 2002, a composite indicator (index) to monitor the readiness of enterprises to conduct business electronically, taking into account that:

- An index would reflect a multi-faceted phenomenon such as e-business (including both internal and external transactions) better than a single indicator (e.g. e-commerce sales / purchases);
- A two-dimensional structure of the index would allow for improved visibility of its results by the target audience of the eEurope benchmarking indicators, generating in parallel the interest of specialists in further investigating the underlying indicators;
- The index should be based on official statistics of pan-European coverage, namely the Eurostat survey on ICT usage by enterprises, to ensure the reliability, comparability and continuity of its results.

The index, endorsed as a pilot exercise by the Council Resolution of 28 January 2003\(^\text{52}\), was composed by twelve basic indicators, grouped into two aggregates (cf. Exhibit 3-4):

- (i) adoption of ICT by business and
- (ii) use of ICT by business.

Similarity of the component indicators

The question arises whether all 12 component indicators are necessary to obtain the envisaged aggregate result, or if some component indicators are so closely related to each other that the list could be reduced without impacting on the result. Nardo et al. (2004) have tested the correlation of the individual component indicators. They find a high correlation for several pairs of indicators, notably for (a1, a2), (a4, a6) and for (b1, b2), (b3, b4) and (b2, b6). High correlation suggests that indicators are partly showing the same aspect of the phenomenon under study, and – as a consequence – that the twelve basic indicators could be grouped in a different way. From a statistical viewpoint, some of the highly correlated component indicators may be redundant. If so, data collection and computation of the compound index could be facilitated.

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\(^{49}\) COM(2002) 263 final

\(^{50}\) Council Resolution No. 5197/03


\(^{52}\) Council Resolution No. 5197/03
Exhibit 3-4: Components of the eEurope 2005 "e-Business Index"

<table>
<thead>
<tr>
<th>Component indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Adoption of ICT by business</td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td>Enterprises that use Internet</td>
</tr>
<tr>
<td>a2</td>
<td>Enterprises that have a web-site/home page</td>
</tr>
<tr>
<td>a3</td>
<td>Enterprises that use at least two security facilities at the time of the survey</td>
</tr>
<tr>
<td>a4</td>
<td>Total number of persons employed using computers in their normal work routine (at least once a week)</td>
</tr>
<tr>
<td>a5</td>
<td>Enterprises having a broadband connection to the Internet</td>
</tr>
<tr>
<td>a6</td>
<td>Enterprises with a LAN and using an Intranet or Extranet</td>
</tr>
<tr>
<td>B) Use of ICT by business</td>
<td></td>
</tr>
<tr>
<td>b1</td>
<td>Enterprises that have purchased products / services via the internet, EDI or any other computer mediated network where these are &gt;1% of total purchases</td>
</tr>
<tr>
<td>b2</td>
<td>Enterprises that have received orders via the internet, EDI or any other computer mediated network where these are &gt;1% of total turnover</td>
</tr>
<tr>
<td>b3</td>
<td>Enterprises whose IT systems for managing orders or purchases are linked automatically with other internal IT systems</td>
</tr>
<tr>
<td>b4</td>
<td>Enterprises whose IT systems are linked automatically to IT systems of suppliers or customers outside their enterprise group</td>
</tr>
<tr>
<td>b5</td>
<td>Enterprises with Internet access using the internet for banking and financial services</td>
</tr>
<tr>
<td>b6</td>
<td>Enterprises that have sold products to other enterprises via a presence on specialised internet market places</td>
</tr>
</tbody>
</table>

The choice of component indicators

Summarising the results of their statistical checks, Nardo et al. (2004) conclude that "the e-business readiness indicator (…) might be used for analysing the countries' performance in ICT". Regarding the selection of component indicators, they state that "some important elements of 'Access' and 'Use' of ICT are currently missing (e.g., e-skills, ICT influence on enterprise organisation and management, internet connection costs, etc.)."

The suggestion of including additional indicators that cover dimensions such as e-skills or connection costs bear new risks and challenges, however. Firstly, such elements are unfortunately not covered (yet) by the Eurostat survey on ICT use in enterprises. Secondly, quantitative data on "e-skills" and on the "ICT influence on enterprise organisation" are, in general, extremely difficult to obtain: the underlying concepts are difficult to translate into simple indicators – for example, an indicator for e-skills that can be quantified and that applies to companies from different sectors is very difficult to specify. The same applies to the ICT influence on enterprise organisation. Furthermore, it should be carefully considered whether indicators on e-business activity and on impacts ("ICT influence on enterprise organisation") should be merged.

Finally, the suggestion to include indicators on Internet connection costs would imply that the index considers both business activity and the market environment (on which businesses have little influence themselves). It is possible to aggregate indicators on both dimensions (firm activity and market environment), but it must be clear that this makes the index much broader (and less specific).

53 Electronic Data Interchange
The issue of thresholds

It was decided to give equal weights to all component indicators. However, it must also be considered whether the range of indicator percentages is really from 0-100, or whether upper or minimum thresholds should be introduced.

For example, for some dimensions or component variables, it may be appropriate to speak of full e-readiness already if a quite low level of actual diffusion is achieved. This may be the case if certain critical masses are achieved so that (the absence of) network externalities no longer constitute a barrier to rapid and broad uptake to speak of full e-readiness. On the other hand, for basic indicators such as "enterprises that use the internet" a lower minimum threshold may be considered.

Thresholds are basically another way of weighting indicators. If "goalposts" are introduced, differences become more pronounced. For instance, a difference of 10 percentage points in one of the indicators has twice the weight if goalposts have reduced the possible range of values from 0-100 (initially) to 50-100.

The problem with introducing goalposts is that their selection and definition is rather arbitrary, like the weighting of indicators by their relative importance. A survey among members of the European Commission's e-Business Support Network (www.e-bsn.org) has shown that even among experts and policy-makers there are different views about the relative importance of the various component indicators (Nardo et al. 2004).

Conclusion

The (eEurope 2005) e-Business Index is a quite ambitious "project" for benchmarking electronic business maturity in different countries (or sectors, size-bands). The goal was to reduce the complexity of the underlying concepts of electronic business by condensing different aspects into one final metric. However, the Index is confronted with several challenges:

- First, the "life cycle" of component indicators is sensitive to the rapid development of electronic business. For example, "enterprises that use the internet" used to be a valid metric for ICT uptake until 2-3 years ago, but is no longer a good indicator in advanced economies. This also applies to the existence of a website.

- Second, there are different opinions on whether the index should be "broadened" in the sense of covering different dimensions of e-business (e.g. skills) and possibly even external factors (such as connection costs), or whether it should be even more focused, for example by concentrating on core e-business activities (transactions between companies and their customers and suppliers).

Other challenges are not specific to this index, but are general issues that apply to all compound indices, as discussed in this report.

As with many indices, "the proof of the pudding is in the eating": the practical value of an index (for policy-making, for triggering debate, for visualising the status-quo) can only be tested if it is practically applied and used. It is recommended to use the index as it is, which means to apply it for presenting results of e-business surveys, in particular of the Eurostat survey on ICT use by enterprises. Currently, it appears that methodological concerns and the respective debate outweigh the practical application of the e-Business Index.

54 "Goalposts" are minimum and maximum thresholds which specify 0 and 100.
4 Policy recommendations

This chapter presents conclusions from the first part of this report in the form of recommendations to policy-makers. Policy is not only an important user of statistics on ICT diffusion and impacts, but is also in charge of making the necessary provisions so that these statistics are available in high quality. The recommendations address both aspects – the adequate use of statistics, and mechanisms to further improve the quality of indicators.

<table>
<thead>
<tr>
<th>Policy objective</th>
<th>Suggestions for policy</th>
</tr>
</thead>
</table>
| 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 European information society and economy development |

Strengthening links and interfaces ...

a) ... between (regular) official statistics and (one-off) research projects:

New data requirements put forward by policy-makers need to be translated into operational, sustainable survey questions. One-off studies and research projects on indicator development have the advantage that they can take risks and pilot new approaches. Moreover, as they do not need to coordinate a large number of statistical institutions from many countries, they can deliver results fast. However, being one-off efforts, they cannot substitute the requirements for regular statistics on the national and European level.

It is important to understand that official statistics and one-off studies should not be regarded as competing each other. Rather, a research project should – ideally – offer suggestions and lessons learned which official statistics can then consider for their own work. Policy is well advised to make use both types of statistics, and to actively encourage exchange and debate between their providers. In the area of e-business, several workshops (e.g., by OECD, Eurostat and e-Business W@tch) have provided a platform for debate in the past 2-3 years. The experience was very positive: all parties involved have benefited from this exchange.

b) ... between closely related regular surveys carried out by official statistics:

The study of electronic business has close links to the study of innovation, productivity, competitiveness, as well as to the analysis of value networks and of structural changes in industry. Regular surveys such as the Community Innovation Survey (CIS) or the Structural Business Survey (SBS) provide important empirical evidence on these issues. If it is recognised that e-business has implications for innovation and industry structure, it is quite obvious that the instruments used to study these concepts should also be linked to each other. This does not mean, however, that the questionnaires should be merged; it is more

55 Risk is a characteristic feature of "projects" by definition
likely that synergies between the different surveys could be achieved, and that new insights could be gained from "amplifying effects" if analysis considers evidence from several sources in parallel.

Recently, initial efforts have been made to link information society statistics with structural business statistics and innovation statistics by using micro data. Such efforts have been made by the statistical offices of certain EU Member States, notably in Finland, Italy, Netherlands and the UK (cf. Eurostat 2003, p. 11; ONS 2003, as presented in chapter 2.2).

Experience has shown that this is a very difficult and challenging process. Policy should, therefore, encourage and support further activity in linking statistics from different sources. This type of activity would not only lead to new insights, but possibly also save costs in the long run by streamlining instruments and analysis processes.

**Carry on efforts to develop meaningful compound indicators for the information society and economy**

Compound indicators have always been an important instrument in the financial sector and in economics. Recently, they have experienced a surge in popularity also in other policy areas, including the ones related to information society, mainly because of their promise to capture and reduce complexity of multi-dimensional concepts. The strengths and risks of compound indicators have been discussed in the previous chapter of this report; the debate about their merits versus their unwanted effects because of inadequate interpretation of results is likely to continue.

The authors of this study believe that policy should not shy away from using and actively promoting the development of CIs. There are many good examples of the usefulness of CIs, particularly in policy areas which do not lend themselves to be measured by one or two simple indicators only. The "Human Development Index" of the United Nations, indices on pollution and environmental development, or corruption indices can serve as examples.

The value of CIs increases significantly once an index has been established to be calculated in regular intervals, provided that changes (e.g. from year to year) are statistically valid. This allows for monitoring the development and the changes, in addition to comparing units at one point of time.

Although the development of indices on ICT and e-business is particularly challenging, due to the change of the underlying technologies and concepts, policy is well advised to encourage related activities and to use resulting indices in the debate about policy objectives and targets. There are two important aspects, however, that have to be taken into account for good use of compound indicators:

- Firstly, some basic quality criteria have to be observed when developing compound indicators (cf. chapter 3.2 – quality assessment of compound indicators);
- secondly, even more importantly, figures should be used predominantly as a starting point for asking questions and to trigger debate.

It must be clear that neither policy objectives nor measures can be directly derived from figures provided by CIs. The figures cannot tell us what to do; they can help us explain the situation. The following recommendation builds on this comment.
A Guide to Indicators on ICT Use by Firms

Use compound indicators as a vehicle to trigger public debate

Indices are a powerful instrument to trigger public debate about policy objectives, particularly if they involve a clear benchmarking element (e.g. for the performance of countries or regions). Policy should capitalise on this potential of compound indices to counteract widespread disenchantment with politics among the population, and thus to refresh democracy.\(^{56}\) The PISA study (Programme for International Student Assessment)\(^ {57}\) is an excellent example of this mechanism. Although there is legitimate criticism on the simplification of results in the way they have been presented in the general media, PISA was a highly effective catalyst to trigger a debate on educational policy in several countries of the European Union. It is also a good example for showing that indices normally do not provide the answers, but help to ask the right questions, such as: "Why did our country score low in the literacy or mathematical skills of our pupils?"\(^ {57}\)

Similarly, a well-designed Information Society Index or an improved e-Business Index could stimulate debate about policy objectives in areas such as innovation, technology, research and development. It is not to be expected that these policy areas are as popular as educational policy, which is more tangible for citizens in their everyday life. Thus, an information society index may not have the same impact on public debate as the PISA study. Nevertheless, the index may be a catalyst to stimulate debate among target constituencies other than citizens, which again can be a desirable goal for creating and launching an index.

The enlargement of the European Union has further increased the demand for intuitively comprehensible measures about the situation in the new Member States (as well as in the "old" Member States, of course). Well-designed compound indicators could greatly facilitate the monitoring process whether alignment of States in various socio-economic dimensions is progressing or not. In this context, innovative compound indicators could be a pro-active move and statement of the European Union to define desirable socio-economic outcomes rather than focusing on purely output oriented indicators only (such as GDP, productivity) which fall short of explaining quality of life if not complemented by other metrics.\(^ {58}\) The following recommendation builds upon this idea.

Going beyond GDP: Apply the "Balanced Scorecard" technique for monitoring European information society and economy development

The Balanced Scorecard (BSC) is a tool for management and controlling that was developed in the 1990s by Robert Kaplan (Harvard Business School) and David Norton. It recognizes weaknesses of controlling tools that are purely focused on financial outcomes and as such on past performance. The balanced scorecard provides a prescription as to what companies should measure in order to “balance” the financial perspective. The BSC approach suggests that the organisation should be viewed from four perspectives:

- the customer perspective (e.g., customer satisfaction),
- internal business processes (e.g., production times),
- the employee perspective (e.g., skills development) and
- the financial perspective as the outcome of the other three dimensions.\(^ {59}\)

\(^{56}\) Taking into account the growing alienation of people from the political debate and bearing in mind that the line between politics and policy-making is, often, rather thin.

\(^{57}\) The PISA study (Programme for International Student Assessment) is conducted among a nationally representative sample of 15-year-old students. It investigates reading and mathematics skills.

\(^{58}\) Many authors have addressed this shortcoming. As one of the most recent and prominent publications, cf. Jeremy Rifkin (2004): The European Dream.

These considerations also apply to the use of policy and economic indicators in many ways. Some of the most widely used indicators and indices are rather questionable in terms of the significance they are supposed to have. The limitations and shortcomings of GDP as an indicator for sustained economic well-being, and alternative approaches to overcome these shortcomings, have been touched upon in this report. The complexity of the problems policy has to address in the 21st century will give rise to this debate.

It is clearly beyond this study to make suggestions for a BSC of socio-economic indicators and indices in the broad sense. Similar to the BSC approach, where metrics are typically defined for the whole company and then broken down to individual departments or profit centres, a system could be established for each policy issue. Monitoring information society and e-business developments could be such issues. In a way, the European Union could be using the BSC approach to break down its policy objectives into sets of activities, each with a number of measurable metrics. Targets could then be specified and their achievement regularly monitored on the basis of these metrics.  

Exhibit 4-1: The E-Business Scoreboard – a "balanced scorecard" for ICT use in enterprises

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**Customer-facing applications**
- Website maintenance with content management systems
- Use of Customer Relationship Management (CRM) systems
- Online selling activity
- Use of specific IT solutions to support sales processes

**Supplier-facing applications and supply-chain management**
- Online purchasing activity
- Use of specific IT solutions to support procurement processes
- Use of online auctions and negotiations
- Use of Supply Chain Management (SCM) systems

**Internal processes**
- Use of an Intranet
- Use of Enterprise Resource Planning (ERP) systems
- Firms tracking working hours and/or production time
- Use of e-learning

**ICT Infrastructure**
- Internet connectivity
- Use of Local Area Networks (LAN)
- Use of a Virtual Private Network (VPN)
- Remote access to the firm’s computer network

Source: e-Business W@tch

---

The e-Business Scoreboard, as developed by e-Business W@tch, is a simple, first effort towards establishing such a system based on BSC principles. It is a four-dimensional system, with basic ICT infrastructure as a pre-requisite for the other three dimensions for which indicators can then be selected.

The model shown in Exhibit 4-1 should be considered as a first step to trigger debate whether this approach could be useful as a monitoring and steering instrument in other policy areas as well. e-Business W@tch has experienced quite positive feedback on the Scoreboard; most readers found it helpful to look at "electronic business" from four perspectives and to define metrics for each of them.

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**Introduction to Part II of the Report**

The following chapters (part II) of this report features two pilot studies that demonstrate how specific, innovative methods can be used to present indicators on ICT diffusion.

- The first pilot study, which 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, introduces the concept of "S-time-distances". Based on e-Business W@tch data, it is demonstrated how differences in e-commerce adoption between sectors and countries can be expressed as a relative time lag in the development.

- The second, shorter pilot was contributed by Ingo Meyer, empirica GmbH, and introduces "correspondence analysis" as a descriptive approach for condensing and visualising large data sets.
5 Sectoral time-distances in the adoption of e-commerce activity

5.1 S-time-distances: concept and definition

Time, as well as 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 dominant 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 the use of time distance as a measure of difference (disparity or proximity), a special category of time distance is defined, 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 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 \( X_L \)

\[
S_{ij}(X_L) = \Delta T(X_L) = t_i(X_L) - t_j(X_L)
\]  

---

61 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.
where $T$ is determined by $X_t$. In special cases $T$ can be a function of the level of the indicator $X_t$, 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 $X_t$ be related to time ($T_1, T_2, \ldots T_n$). 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 the *e-Business Survey* 2003, a comparison of percentage of enterprises buying and selling online for all sectors will be used first 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 also shows the yearly growth rates of the variable. Obviously the yearly growth of percentages of enterprises buying and selling online is exceptionally high: one is dealing 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 such as 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

<table>
<thead>
<tr>
<th>Time</th>
<th>Percentage</th>
<th>Yearly growth rate (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Buying online</td>
<td>Selling online</td>
</tr>
<tr>
<td>1995</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>1996</td>
<td>1.4</td>
<td>0.3</td>
</tr>
<tr>
<td>1997</td>
<td>1.9</td>
<td>0.4</td>
</tr>
<tr>
<td>1998</td>
<td>3.5</td>
<td>0.7</td>
</tr>
<tr>
<td>1999</td>
<td>6.6</td>
<td>1.6</td>
</tr>
<tr>
<td>2000</td>
<td>10.8</td>
<td>2.5</td>
</tr>
<tr>
<td>2001</td>
<td>16.8</td>
<td>4.9</td>
</tr>
<tr>
<td>2002</td>
<td>24.1</td>
<td>6.6</td>
</tr>
<tr>
<td>2003</td>
<td>30.3</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Source: SICENTER / e-Business W@tch (2005)
Exhibit 5-2: Various measures of difference between buying and selling online for all sectors

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

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 increases 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

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. An additional perspective to the situation is shown 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 such as 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.\textsuperscript{62}

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

\textsuperscript{62} 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 - in many cases this would be very helpful and may change the overall conclusions.

In 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 comparison is sought in the horizontal dimension, a search is made 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 shows 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 two things. Firstly, equal vertical distances between two time series mean equal relative differences between the compared time series at a given point in time. Secondly, 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 initially 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 detail in the European e-Business Report, 2004 edition (European Commission 2004), online buying is much more prevalent than online selling. In this analysis for all sectors it has already 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 - 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) the time distance gap between 10 analysed sectors in the above mentioned report is being examined. 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. For example, 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)**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT services</td>
<td>-33</td>
<td>-37</td>
<td>-33</td>
<td>-35</td>
<td>-42</td>
<td>-50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>-14</td>
<td>-10</td>
<td>-14</td>
<td>-18</td>
<td>-22</td>
<td>-29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tourism</td>
<td>-17</td>
<td>3</td>
<td>-1</td>
<td>-5</td>
<td>-8</td>
<td>-12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business services</td>
<td>-1</td>
<td>-5</td>
<td>-5</td>
<td>-4</td>
<td>-3</td>
<td>-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>-3</td>
<td>-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sectors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>6</td>
<td>-2</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>Retail</td>
<td>19</td>
<td>10</td>
<td>16</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>1</td>
<td>12</td>
<td>17</td>
<td>20</td>
<td>16</td>
<td>16</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Craft &amp; trade</td>
<td>37</td>
<td>24</td>
<td>22</td>
<td>21</td>
<td>19</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textile</td>
<td>14</td>
<td>18</td>
<td>24</td>
<td>23</td>
<td>23</td>
<td>32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 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 (more than 4 years and 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 behind 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 also be analysed 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**

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

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 for 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. Only a few of all possible comparisons from such a table-graph will be mentioned here. 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 tourism, but the time distance with the average for all sectors at that level cannot be determined since, for example, the textile sector has not reached that level yet (for details on possible analysis of such time matrix see Sicherl, 2003).

Exhibit 5-1 also showed 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 is dealing 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 in the example of buying online for the ICT services sector which has reached the highest percentage of all sectors. However, the conclusions will also be relevant 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 weighted 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

<table>
<thead>
<tr>
<th>Year</th>
<th>ICT services</th>
<th>All sectors</th>
<th>Yearly growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>2.3</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>6.7</td>
<td>1.4</td>
<td>187</td>
</tr>
<tr>
<td>1997</td>
<td>9.5</td>
<td>1.9</td>
<td>43</td>
</tr>
<tr>
<td>1998</td>
<td>14.4</td>
<td>3.5</td>
<td>50</td>
</tr>
<tr>
<td>1999</td>
<td>32.4</td>
<td>6.6</td>
<td>126</td>
</tr>
<tr>
<td>2000</td>
<td>46.4</td>
<td>10.8</td>
<td>43</td>
</tr>
<tr>
<td>2001</td>
<td>62.1</td>
<td>16.8</td>
<td>34</td>
</tr>
<tr>
<td>2002</td>
<td>68.1</td>
<td>24.1</td>
<td>10</td>
</tr>
<tr>
<td>2003</td>
<td>74.5</td>
<td>30.3</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: SICENTER / e-Business Watch (2005)

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

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

Source: SICENTER / e-Business Watch (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 online buying for the ICT services sector 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 no longer increasing and that relative differences are falling. The S-time-distance, however, has increased in the last two years; in 1998 it was 33 months, in March 2003 50 months.

Theoretically it can be shown that, 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 arriving at 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 had taken the lead over the large enterprises. Only in 2001 was the diffusion of buying online again higher in the large enterprises, which continued to lead after that. For that reason, in estimating 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 low percentage of enterprises engaged in purchasing online. As mentioned above, this process of leading and lagging of diffusion by the size of enterprises reversed until 2001. After that, the time lead of large enterprises started to increase substantially. In March 2003 the medium enterprises were lagging for about one year (size 50-249 for 11 months and 10-49 for 16 months), while 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)**

<table>
<thead>
<tr>
<th>Time</th>
<th>1-9</th>
<th>10-49</th>
<th>50-249</th>
<th>250+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>19</td>
<td>17</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>11</td>
<td>9</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>-2</td>
<td>-5</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>9</td>
<td>0</td>
<td>-5</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>19</td>
<td>8</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>27</td>
<td>16</td>
<td>11</td>
<td>0</td>
</tr>
</tbody>
</table>

(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 also provides 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 it was used as the benchmark country for calculating the time distances between countries. The results are presented in two ways. Exhibit 5-12 shows the estimates of S-time-distances from the values experienced in the UK. German firms follows the companies from the UK rather closely; the time lag is around one year, sometimes less. Italian and France enterprises are in a similar relative position to the UK; their time lag is about 2 years. Spanish firms lags behind the companies from the UK by 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)

<table>
<thead>
<tr>
<th>Time</th>
<th>UK</th>
<th>DE</th>
<th>IT</th>
<th>FR</th>
<th>ES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>0</td>
<td>9</td>
<td>26</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td>1999</td>
<td>0</td>
<td>11</td>
<td>19</td>
<td>21</td>
<td>41</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>14</td>
<td>22</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>7</td>
<td>20</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>6</td>
<td>24</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>14</td>
<td>26</td>
<td>25</td>
<td>37</td>
</tr>
</tbody>
</table>

(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 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

<table>
<thead>
<tr>
<th>Level</th>
<th>UK</th>
<th>DE</th>
<th>IT</th>
<th>FR</th>
<th>ES</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Aug-97</td>
<td>May-98</td>
<td>Mar-99</td>
<td>Apr-99</td>
<td>Dec-99</td>
</tr>
<tr>
<td>10</td>
<td>Aug-98</td>
<td>Aug-99</td>
<td>Jun-00</td>
<td>Sep-00</td>
<td>Jun-01</td>
</tr>
<tr>
<td>15</td>
<td>Apr-99</td>
<td>May-00</td>
<td>Jan-01</td>
<td>Nov-01</td>
<td>Jun-02</td>
</tr>
<tr>
<td>20</td>
<td>Apr-00</td>
<td>Dec-00</td>
<td>Mar-02</td>
<td>Jul-02</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Dec-00</td>
<td>May-01</td>
<td>Jan-03</td>
<td>Jan-03</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Jun-01</td>
<td>Nov-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Oct-01</td>
<td></td>
<td>Jun-02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Mar-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Jan-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourism</td>
<td>-33</td>
<td>-27</td>
<td>-32</td>
<td>-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT services</td>
<td>-24</td>
<td>-24</td>
<td>-27</td>
<td>-18</td>
<td>-23</td>
<td>-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sectors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chemical</td>
<td>-8</td>
<td>-17</td>
<td>0</td>
<td>-5</td>
<td>3</td>
<td>-1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>-23</td>
<td>-19</td>
<td>-12</td>
<td>-6</td>
<td>-6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport equipment</td>
<td>7</td>
<td>0</td>
<td>-4</td>
<td>5</td>
<td>9</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>19</td>
<td>23</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craft &amp; trade</td>
<td>35</td>
<td>32</td>
<td>29</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>21</td>
<td>33</td>
<td>34</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business services</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>37</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textile</td>
<td>38</td>
<td>45</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 rapid 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 of chemical, electronics, transport and retail sector. Their time lag behind the average is about half a year. The third group is distinctly lagging behind the others by 36 months (craft & trade) and by a whole 51 months (health and business services and textile).

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 also showed an important time lead as compared to the average but at the end of the period it had 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 online selling – 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 online selling, 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)
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 very much in line with the large enterprises. The only distinct group with a time lag of about 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)**

<table>
<thead>
<tr>
<th>Time</th>
<th>1-9</th>
<th>10-49</th>
<th>50-249</th>
<th>250+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td>-2</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>57</td>
<td>-3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>19</td>
<td>-2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>24</td>
<td>6</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>30</td>
<td>11</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

(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

<table>
<thead>
<tr>
<th>Time</th>
<th>DE</th>
<th>IT</th>
<th>UK</th>
<th>ES</th>
<th>FR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>0</td>
<td>-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>0</td>
<td>12</td>
<td>9</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>0</td>
<td>11</td>
<td>4</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>19</td>
<td>7</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>12</td>
<td>7</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>17</td>
<td>16</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>16</td>
<td>18</td>
<td>21</td>
<td>36</td>
</tr>
</tbody>
</table>

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

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

Among the five countries, German companies stand out as the leaders in diffusion of online selling. Exhibit 5-19 shows that Italian and the firms from the UK are lagging by about 17 months, Spanish enterprises by 21 months and France companies by 3 years. In comparison with buying online the lead role is now changed from the UK firms to German companies and, with respect to the largest time lag, Spanish and France enterprises have changed their relative position..

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

<table>
<thead>
<tr>
<th>Level</th>
<th>DE</th>
<th>IT</th>
<th>UK</th>
<th>ES</th>
<th>FR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Dec-98</td>
<td>Jun-00</td>
<td>Apr-99</td>
<td>Jun-00</td>
<td>Sep-00</td>
</tr>
<tr>
<td>3</td>
<td>Jul-99</td>
<td>Oct-00</td>
<td>Jan-00</td>
<td>Dec-00</td>
<td>May-01</td>
</tr>
<tr>
<td>4</td>
<td>Jan-00</td>
<td>Feb-01</td>
<td>Jul-00</td>
<td>Jun-01</td>
<td>Jun-02</td>
</tr>
<tr>
<td>5</td>
<td>May-00</td>
<td>Jul-01</td>
<td>Nov-00</td>
<td>Feb-02</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sep-00</td>
<td>Jan-02</td>
<td>May-01</td>
<td>Jun-02</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dec-00</td>
<td>May-02</td>
<td>Apr-02</td>
<td>Oct-02</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Apr-01</td>
<td>Sep-02</td>
<td>Sep-02</td>
<td>Jan-03</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Aug-01</td>
<td>Jan-03</td>
<td>Feb-03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Dec-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>May-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Oct-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Mar-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 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.

<table>
<thead>
<tr>
<th>Specific / general</th>
<th>Conclusions and observations</th>
</tr>
</thead>
</table>
| 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 started about 3 years later than online purchasing. However, this does not mean 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

Firstly, in applying the time distance methodology to this pilot case study several conclusions 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 had 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 the static relative disparity is expressed as an index with a 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 were 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 throughout the period is considerably less than buying online, but the additional conclusions brought about by the time distance methodology are very similar to those 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 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, S-time-distances for the lagging sectors are also 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 (craft 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

Secondly, 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 merely enlarged 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 also profoundly affects 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 information available. 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 than 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.
6 A descriptive approach to country comparison using correspondence analysis

6.1 Introduction

Over the last years compound or composite indicators have become the standard methodology when it comes to country comparison based on statistical data. Their popularity has increased remarkably in the recent past mainly due to their ability to condense large data-sets to a few values or even a single value that can be easily interpreted. Policy-makers, other decision-makers and advisors welcomed the compound indicator's resource-saving potential. On the other hand, the discussion among statisticians on the pros and cons of compound indicators has been quite as lively as their popularity surge. Against the more or less obvious advantages of CI-based data interpretation stands a series of disadvantages mainly focused around the questions of the influence of the compound indicator's underlying model, of the aggregation of errors inherent in the data or stemming from the computation process and of the levelling of finer differences in the data. The seeming simplicity and clarity of CI values sometimes result in inappropriately simplistic conclusions.

A first alternative to the use of compound indicators would be the simple descriptive analysis of the data, using methodologies such as cross-tabulation or frequency counts. However, descriptive analysis has its limitations when it comes to large and complex data-sets. Only multivariate methodologies have the statistical robustness which is required for a more complex and thorough investigation of the data.

Another approach is correspondence analysis (CA). This is a descriptive, multivariate method that is model free, inductive, can handle small or large data-sets and all data levels, and produces a graphical output of the results – depicting (dis-)similarities in the data as distances. To be an alternative to the well-established practice of compound indicator development, this method provides

- results based on sound multivariate analysis,
- the reduction of complexity of large data-sets,
- a visualisation of the results,
- a basis for public discussion

while at the same time

- being a descriptive and model-free approach which imposes no additional constrictions on the data:
- allowing the easy interpretation of finer differences,
- and preventing simplistic conclusions without the results being too complicated.

This chapter offers an introduction to the methodology of correspondence analysis, with some general examples of use, and discusses results from the analysis of a data-set used for the measuring of the knowledge society in the EU in light of the above-named requirements. Finally it draws some conclusions as to whether correspondence analysis can really be considered as an alternative to compound indicator development and under what circumstances.

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63 This case study was authored by Ingo Meyer, empirica GmbH.
64 Examples are based on data from the EUFORIA project (‘European Knowledge Society foresights for living conditions, working conditions and industrial relations’). EUFORIA was launched in 2001 by the European Foundation for the Improvement of Living and Working Conditions. It was completed in 2004.
It was not possible, unfortunately, to use data from the *e-Business Survey* 2005 by *e-Business W@tch* for this contribution, mainly for two reasons. First, the data from this survey were not yet available when this report was authored. Therefore, only data from the 2003 survey could have been used. Second, the effort to carry out a completely new CA with a new dataset would have been out of scope just for demonstration purposes, as it is the objective of this chapter. This would rather require a special study in its own right.\(^65\)

### 6.2 Correspondence analysis: methodology

Correspondence analysis is not a new methodology – its first developments date back as far as the 1930s. It has been, and still is, very popular in France, mainly due to the works of Jean-Paul Benzécri and the applications of sociologist Pierre Bourdieu in his lifestyle approach. Its main field of application is the analysis of micro data. Examples for economic applications include the works of Benzécri, Greenacre and Teillard. Benzécri, for example, carried out an analysis on sales and consumption between industry sectors in different countries.\(^66\)

Today, CA is included in almost any important statistical software package both on the commercial side (e.g. SPSS, SAS) and on the non-commercial, open-source side (e.g. the R statistical package).

CA reveals underlying structures in a large data set by reducing its complexity without losing essential information. It is methodologically related to principal components analysis / factor analysis (PCA/FA) and canonical correlation analysis. It can compute discrete and continuous variables.

Results of correspondence analysis are given numerically and visually with both outputs in close relation. Basically, similarities and dissimilarities between the variable values are displayed as spatial distances, where short distance means similarity and long distance dissimilarity. The distances are presented in an n-dimensional space explaining 100% of the variance in the data.

The data input for the analysis is a contingency table of standardised variables. Standardisation is necessary to maintain an equal weighting of the variables, as variables with large values (e.g. GDP when compared to unemployment rate) would be grossly overweighted.\(^67\)

The calculation itself is done in three steps (cf. Exhibit 6-1). The first two steps are carried out separately for the rows and columns (indicators and countries in this example) of the contingency table.

1. The row and column profiles (i.e. the relative frequencies in the table) are calculated, dividing each cell by the row or column sum respectively.
2. The distances between the now relative data points are computed.
3. By minimisation of the weighted sum of the squared distances the n-dimensional space that describes best the variance of the data is computed. The dimensionality of that optimised space is usually lower than the dimensionality of the original data. "Dimensions" are latent variables, comparable to the factors in factor analysis, i.e. they depict common structures in the input data.

\(^{65}\) It is considered to apply this method for a special study in 2006, provided that the *e-Business W@tch* can be extended until the end of 2006.

\(^{66}\) These studies have been published in “Les cahiers de l’analyse des données” [cf. Benzécri 1980; Greenacre, Benzécri 1976; Teillard 1976].

\(^{67}\) For more information on standardisation procedures cf. Greenacre, 1989, chapter 5.
6.3 Measuring the Knowledge Society in the EU: an example

In 2001 the European Foundation for the Improvement of Living and Working Conditions started a project on “European Knowledge Society foresights for living conditions, working conditions and industrial relations” (project acronym “EUFORIA”). The project ended in 2004. The project’s purpose was to increase the understanding of the drivers of the Knowledge society in the EU and to anticipate potential impacts on living conditions, working conditions and industrial relations. Within the course of the project a report on the “Advancement of the knowledge society in the European Union” was written, containing comparative statistical data on several aspects of the Knowledge Society.⁶⁸

Statistical indicators were selected in accordance with an indicator framework developed in the project, covering readiness-factors (infrastructure and resources, socio-economics, politics) as well as outcomes (applications, outputs, markets) and were analysed descriptively. The indicators covered all of the then 15 EU member states. A sub-set of the original indicator selection was used to create so-called country profiles, based on benchmarking scores, comparing each country to the EU-average. The country profiles showed each

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⁶⁸ For further information on EUFORIA and the Knowledge Society Advancement Indicators cf. Korte / Meyer (2003).
country belonging to one of three groups which describe a country's position in knowledge society sophistication:

- *frontrunner* (Denmark, Finland, Netherlands, Sweden)
- *average performer* (Austria, Belgium, France, Germany, Ireland, Luxembourg, United Kingdom) or
- *laggard* (Greece, Italy, Portugal, Spain).

The distribution of countries into the three groups corresponded to the general principle of the north-south gradient and to the results of other studies in this field.

A re-analysis of the country profile data using correspondence analysis confirmed the basic results of the descriptive analysis. It proved that a sub-set of indicators focusing on the issues of education, innovation, labour productivity, social cohesion and basic internet usage can be used to directly measure the knowledge society sophistication of the 15 countries.

The plot for the first two dimensions (or latent variables) is shown in Exhibit 6-2. The indicators with the highest correlation to one of the dimensions are shown as large rhombi connected to their related axis by a dotted line.

**Exhibit 6-2: CA graphical result, 1st & 2nd dimension**

The **first dimension** (horizontal axis in Exhibit 6-2) depicts the level of knowledge society sophistication, increasing from left to right. The three country groups or clusters can be easily discerned, with France and Ireland standing on the threshold of the average performer group. The outlying position of Luxemburg is mainly caused by a high number of missing values and has therefore a low explanatory power.

The indicators connected to the first dimension have the highest correlation with knowledge society sophistication. These are indicators on education (PISA score, pupil-teacher ratio, education expenditure), innovation (innovation capacity), labour productivity, social cohesion (GINI coefficient) and (basic) internet usage. Indicators with a smaller correlation with the knowledge society are practice of tele-work, share of workforce in the third sector, broadband access, work flexibility, R&D expenditure and perceived job satisfaction.
So far, the analysis helped to prove the results gained from the simple descriptive analysis. Furthermore, added value compensating for the effort of a multivariate analysis can be gained from looking at two further dimensions.

What can be seen on both dimensions is that the three groups described above (laggards, average performers and frontrunners) are not as homogeneous as the descriptive analysis and general assumption make them.

The second dimension (vertical axis in Exhibit 6-2) depicts differences among the countries owing to internet access costs, infant mortality and company-provided training. The spread of the countries along this dimension, however, does not follow the strict spatial pattern (from southern to northern countries) of the first dimension. Greece and Portugal still take an outlying position, but Ireland now lies closer to these two than Italy and Spain (i.e. it is more similar to Greece and Portugal in terms of internet access costs, infant mortality and company-provided training than Italy and Spain), whereas France takes a position close to the Netherlands.

The third dimension (shown in Exhibit 6-3 below, vertical axis) depicts differences among the countries in terms of unemployment, labour productivity growth, R&D expenditure, workforce in 3rd sector and (less strong) broadband internet access. The dispersion pattern among the three country groups (esp. among the laggards and frontrunners) is much stronger here. The first dimension again shows the increasing knowledge society sophistication from left to right. Data points with a high correlation to the first dimension are shown as small rhombi (which need not be considered any further here, as there are no differences when compared to Exhibit 6-2), data points with a high correlation to the third dimension are shown as large rhombi connected to the dimension by a dotted line; all others have been omitted.

Exhibit 6-3: CA graphical result, 1st & 3rd dimension

Among the frontrunners, Finland takes an outlying position owing to a relatively high unemployment rate, similar to those of Italy and Spain. It also shows a relatively high labour productivity growth compared to the other two Nordic countries and the Netherlands (the latter having a rather low growth rate). Further on, Finland is separated from the other
frontrunners by a relatively low share of workforce in the third sector and a relatively low number of internet users with broadband access. R&D expenditure is higher in Finland and Sweden than in Denmark and the Netherlands.

The group of average performers remains largely homogeneous with the one exception of the United Kingdom where the share of workforce in the third sector is relatively high when compared to the other countries in that group.

The dispersion among the laggard countries might be the most interesting thing in this analysis. They fall apart into two diverging sub-groups: Italy and Spain on the one side, Greece and Portugal on the other side. Italy and Spain are in this case characterised by their relatively high unemployment rate, when compared to Portugal. Italy and Spain show relatively high R&D expenditure. In contrast, Portugal has a relatively high share of workforce in the third sector, whereas Greece has a low labour productivity growth rate.

What conclusions can be drawn from this analysis? Generally it was shown that:

- A consistent set of indicators exists to measure the sophistication of the knowledge society in the EU, with the core elements described above in the analysis of the first axis.
- The level of sophistication among the 15 EU Member States differs, decreasing from north to south. This is a common finding in surveys on ICT update, both in households and enterprises.
- The influence of basic internet usage on knowledge society sophistication is high, whereas more complex ICT indicators such as broadband access and the digital divide have a lower influence.

In addition, correspondence analysis showed that:

- The north-south gradient is not the only pattern in the data.
- The identified groups are not as homogeneous as is commonly assumed.
- The southern countries are not simply all-area “laggards”, but show strengths and promise in some points, which might serve as starting points for further changes.

These last points in particular show one of the immanent strengths of correspondence analysis: the detection of undiscovered and small, yet meaningful patterns in statistical data.

### 6.4 Conclusions

Correspondence analysis (CA) represents an alternative way of performing country comparisons based on statistical indicators. Not only is CA comparable to standard compound indicator based methodologies, it also provides coping strategies for some of the disadvantages of compound indicators. Due to the descriptive character of the methodology the data are not subjected to the usually error-prone modelling and/or aggregation process. The data-level (nominal, ordinal, interval) does not matter. In addition the results (especially those shown in the graphical output) lend themselves to discussion very naturally, not pretending to be the “one and only solution” to a problem. Thus, the danger of immature or overly simplistic conclusions is avoided, which is not always the case when conclusions are drawn from seemingly clear-cut index values. The graphical output, which can be a useful instrument to visualise results, is inherent to the methodology and must not be produced as an additional effort.

The advantages of CA are:

- Data remain unchanged by the calculation process
- All data-levels can be handled
- Visualisation is part of the methodology
- Results lend themselves to discussion
- Results are not overly simplistic
- Fine differences in the data can be interpreted

On the other hand, the biggest disadvantage of correspondence analysis is that, up-to-date, it remains largely unknown in most EU countries and the general public. The only exception to this is France, where CA cannot only look upon a long and successful history of use among statisticians (sometimes even being used synonymously for statistics in general), but is also used excessively in public media. Unfortunately, the language barrier (most of the literature being available only in French for a long time) and the strong influence of the Anglo-American statistical tradition in the rest of Europe have prevented the diffusion of CA for years. This might be a barrier for the use of CA in the official statistics in the EU, as it requires a certain predisposition for this type of descriptive analysis. Moreover, results do not lend themselves to drawing immediate conclusions, but need to be discussed and put into perspective. This process requires some guidance from experts who are familiar with CA.

Thus, the disadvantages of CA can be summarised as follows:
- The method is relatively unknown, except in France;
- it requires a certain predisposition for descriptive analysis;
- guidance is needed for the discussion of results and their implications.

Notwithstanding these barriers, CA delivers an accurate insight into the underlying structures of a data-set. This allows the finding and discussion of patterns and implications that would otherwise possibly remain undiscovered.

The method could also be applied to the presentation of e-business related data. CA could help, for example, to gain a better insight which indicators on ICT use explain best the overall intensity of electronic business activity. CA could also be used as an instrument to group sectors or countries according to different dimensions of ICT and e-business adoption, and thus to validate common assumptions on the relative e-maturity of these sectors or countries.
Part I


Booysen, F. (2002). An overview and evaluation of composite indices of development


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**Part IIA: Sectoral time-distances**


**Part IIb: Correspondence analysis**


