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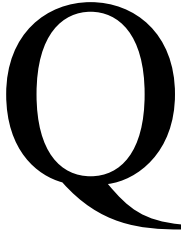
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QUALITY CONCEPT FOR OFFICIAL STATISTICS

In everyday language *quality* refers to where, on a scale bad-good-excellent, a user places a certain product with regard to its intended use and in comparison with similar products. Sometimes the word "quality" is given a positive value, and is taken as a synonym for "good quality." This makes the notion somewhat difficult to handle, and different definitions have been used.

Even if the definition of quality has varied over time, quality improvement, control, assurance etc. have always concerned producers of goods and services. The current dominating approach to quality issues is based on the notion of *total quality*, which has the following main ingredients.

1. A product's quality is determined by both the existing and potential opinions of users of the product and its fitness for their purposes in using it.
2. The quality concept should reflect *all aspects of a product* that affect users' views on how well the product meets their needs and expectations.

With this definition quality has a *descriptive* meaning for the producer. The producer's qual-

ity concept should not take a stand on whether the product is of good or bad quality in any absolute sense.

Quality assessment is left to the users, who are entitled to have subjective opinions on whether the quality is good or bad. Their assessments do not depend on the product alone, but on a combination of product and purpose. A certain product may be judged to be of good quality in one application and bad in another. For the producer it is, of course, essential to learn about users' opinions. since they constitute the basis for work aimed at higher quality, in the sense of greater user satisfaction.

QUALITY OF OFFICIAL STATISTICS

In the official statistics context the core part of a "product" consists of *statistics*, i.e. estimates of *statistical characteristics*. Such characteristics are numeric values that summarize individual *variable* values for the *units* (households, enterprises, farms, etc.) in a specific *group* via some *statistical measure* (total, mean, median, etc.). the total collection of units of interest is the *population*. In most surveys the interest involves statistics not only for the entire population, but also for different subgroups, called *study domains*.

We speak of "estimates" not only when the statistics emanate from sample surveys, but

also when, they come from total enumeration surveys. In the latter case one should ideally achieve exact figures, but reality is seldom ideal. Surveys are subject to various kinds of disturbances. Therefore, statistical characteristics are referred to as *target characteristics*.

Quality considerations may relate to "statistics products" of different scope, from a single figure in a table cell to the entire outflow from a system of statistics sources, with survey repetitions over time as a vital ingredient. The quality concept to be formulated is meant to be wide enough to cover any type of such product.

Nowadays many producers of official statistics have adopted the total quality approach, in which the notion of "quality of statistics" takes the following form.

Quality of statistics refers to all aspects of how well statistics meet users' needs and expectations of statistical information, once disseminated.

In accordance with ingredient 2, the quality concept should list all aspects of statistics implicit in this definition. When making the concept concrete, it is natural to group the aspects by main *quality components* with subcomponents. This structure is used in the quality concept formulated in Table 1. However, even if there is wide agreement on what the subcomponents should be, there is no universal consensus on how to group them under main components. The grouping in Table 1 blends many views, notably those of Statistics Sweden* and Eurostat.

The quality concept is used in the following areas:

Quality Declarations. To be able to use statistics adequately, users require information about their properties. For this purpose the producer should provide neutral, descriptive information, commonly called a *quality declaration*.

Survey Planning. For a producer, as well as for a user with influence on the planning of a statistical survey (e.g. by financing it), the quality concept gives a checklist of quality aspects to take into

Table 1 Quality Concept for Official Statistics

Contents of reports
Statistical target characteristics
Units and population
Variables
Statistical measures
Study domains
Reference time
Comprehensiveness
Accuracy
Overall accuracy
Sources of inaccuracy
Sampling
Coverage
Measurement
Nonresponse Data
Data processing
Model assumptions
Presentation of accuracy measures
Timeliness
Frequency
Production time
Punctuality
Coherence, especially comparability
Comparability over time
Comparability over space
Coherence in general
Availability and clarity
Forms of dissemination
Presentation
Documentation
Access to micro data
Information services

Productivity Evaluation and Quality Improvement

The processes that produce statistics need evaluation and revision with regard to costs and benefits of the resource allocation. The quality concept provides a basis for such analyses.

The quality declaration context highlights the descriptive side of the quality concept. In the two other contexts it is important for the producer to know about users' assessments of quality and their preferences. The vehicle for this task is dialogue between the user and producer of statistics.

General Comments

1. Producers are well aware that users pay considerable regard to the *cost* of a

Cost is not included as a quality component, however, in line with the general philosophy of quality. Often quality improvements can be achieved without increased cost. However, quality and **cost** have to be appropriately balanced in a final round.

2. False official statistics appear sometimes, **statistics that are not objective**. This is, of course, a serious quality defect, but objectivity is not included as an aspect of the quality concept for two reasons. (1) We believe that deliberately false official statistics are exceptional. (2) It is difficult to discuss, and assess, the objectivity aspect openly.
3. Some writers use the term *relevance* instead of contents, while others (including the present authors) think that the term leans too much to the assessing side. It should be the user's privilege to judge if specific statistics are relevant.

Some writers advocate a broader quality concept, which takes into consideration not only the users but also the data *suppliers*. Then *response burden*, *confidentiality*, and *integrity* would enter the quality picture.

Most producers have good knowledge of users' quality preferences—at least? of whether users will regard a particular production change as a step in a positive or negative quality direction. Essentially all users agree on direction, but they often disagree on the weight they assign to a specific quality change. Moreover, a production change may have a positive effect on some quality components and a negative effect on others. Hence, conflicting interests often prevail between and within users.

The following elaborates on the quality components, their descriptive side, and indications of conflicting interests.

CONTENTS

Users' requirements for *statistical information*, i.e. information on values of statistical characteristics, emanate from *their subject-matter problems*. These may concern issues of economics, demography, environment, and many

more. The preferable choices of units, population, variables, etc. in the target characteristics depend on the subject-matter problem. Hence, *relevance* is not an intrinsic property of statistics, but relates to the subject-matter problem.

A specific set of target characteristics can make the statistics highly relevant for some users, but less relevant for others. Conflicting interests often turn up, and compromises have to be made. Even if there is consensus about the most suitable target characteristics, considerations concerning cost, timeliness, measurement difficulties, etc. may lead to "second best" choices.

The descriptive aspect of *study domains* concerns answers to the following questions:

- Which types of classifications are used to form study domains?
- How far-reaching are the subdivisions into study domains?

Users commonly present very extensive requirements as regards statistics for small domains, but there are restraining factors. One is that data on a requested classification variable may not be available (e.g. for cost reasons); another, that statistics for many domains require overly extensive publication space.

Additionally, when sample survey statistics are broken down to smaller and smaller domains, their accuracy deteriorates. Ultimately it becomes so low that the statistics no longer are meaningful, and the breakdown process has to be terminated at an appropriate level.

Units and variable values relate to specific times, which may be narrowly delimited and are called *reference time points* (e.g. a specific day), or *reference periods* (e.g. a calendar year). Usually reference times agree for all variables and units, but they may differ. (Example: A survey target could concern salaries in 1985 and in 1995 for students who graduated from a particular educational institution in 1975.)

Comprehensiveness refers to a system of statistics for a specific subject matter field (example: the totality of economic statistics from the national statistics system). Many users want the statistics system to provide information on "all vital respects." The better this request is

met, the more comprehensive is the statistics system. In practice no national statistics system can satisfy all users according to their interpretation of "all vital respects."

ACCURACY

Accuracy concerns the agreement between statistics and target characteristics. In a sample survey, the resulting statistics do not provide exact values of the target characteristics. Moreover total enumeration surveys are usually subject to so many disturbances that the resulting statistics should be regarded as estimates rather than exact values. Normally here is a *discrepancy* between the values of a statistic and its target characteristic, also referred to as an *error*. The (relatively) smaller the discrepancy is, the more *accurate* is the statistic. Discrepancies should be small, preferably negligible.

Often, however, discrepancies are not negligible, in particular for sample survey statistics. Then statistically knowledgeable users want numerical bounds for the discrepancies, called *accuracy measures* or *uncertainty measures*. Exhibition of accuracy measures is somewhat intricate, since the discrepancies are defined in terms of target values that are unknown. (If they were known, it would be unnecessary to estimate them.) Statements concerning accuracy are therefore inevitably statements about states of uncertainty, a conceptually difficult topic. The usual structure for information about accuracy is as follows (in a non-technical it is most likely that a specified interval of the type

accuracy (or uncertainty) interval

= value for the statistic

" *margin of uncertainty (error)*

comprises the true value of the target characteristic.

Sometimes such an interval can be interpreted as a *confidence interval** with a specified confidence level, which in official statistics is often chosen to be 95%70. Other

measures are in essence equivalent to a confidence interval: the estimator's *standard deviation**, *relative margin of error*, and *coefficient of variation**.

Overall Accuracy

Here interest is focused on the overall reliability of a statistic, in other words on the magnitude of the *total error*.

In some cases the producer can provide precise overall accuracy intervals, but this is the exception rather than the rule. However, lacking precise bounds for total errors, the producer should do his/her best to provide information on, or at least judgments of, how certain source(s) of inaccuracy have affected the statistics. This is considered under the next quality component.

Sources of Inaccuracy

Classifications of error source usually employ the duality of *sampling errors* versus *general survey errors* (often called *nonsampling errors*). The former relate to sample surveys, and emanate from the fact that only a sample of population units, not all, are observed. The latter relate to the error sources to which all types of surveys are subject, total enumeration surveys as well as sample surveys.

Another common classification duality is that of *systematic errors*, which lead to bias in the statistics, versus *random errors*. The former relate to errors which (for the majority of observations) go in the same direction, the latter to errors which spread randomly around 0. In this context the accuracy is commonly divided into the components *bias* (size of the systematic error) and *precision* (bound for the random error).

The *total error* (i.e. the discrepancy between a statistic and its target value) is often viewed as a sum of partial errors, emanating from different error sources:

Total error = sampling error + coverage error

+ measurement error

+ nonresponse error + . . .

Even if it is difficult to give quantitative bounds for the total error, it is often possible to provide accuracy information for at least some of the partial errors.

In quality declarations the producer should, in addition to potential numerical error bounds, provide a verbal account of the data collection*, including obstacles encountered.

We now turn to the main sources of inaccuracy.

SAMPLING. The fact that only a sample or population units are observed in a sample survey contributes to the inaccuracy of the resulting statistics.

One distinction is that of *probability samples* (yielding control of sample inclusion probabilities) versus *nonprobability samples* ("expert samples" and "subjective samples" are synonyms). Probability sampling is a safeguard against bias; moreover, bounds for the sampling error can usually be given in terms of confidence intervals.

GENERAL SURVEY ERROR SOURCES. Disagreement between survey frame and target population leads to *coverage error*. A *measurement error* occurs if a respondent's answer differs from the true variable value. Measurement errors may be systematic (e.g. underreporting of income) or random. Systematic measurement errors lead to biased statistics. The contribution to inaccuracy from random measurement errors is mostly covered by the sampling error confidence interval.

Nonresponse occurs when values for a designated observation unit have not been collected at the time when the estimation process starts. Nonresponses may lead to bias if there is correlation between nonresponse and the value of the survey variable. Various procedures exist for adjustment, in the best possible manner, for nonresponse.

Nonresponse rates are commonly reported. They indicate the quality of the data collection process, but do not give information about the crucial quantity, the order of magnitude of the nonresponse error.

Collected data are processed in different steps, such as data entry, coding, editing, and

estimation/aggregation. At each step of *data processing* mistakes/mishaps may occur, contributing to inaccuracy.

Some statistics rely on assumptions (e.g. Stability of a consumption pattern), also referred to as models. A *model assumption* that is not perfectly fulfilled contributes to inaccuracy.

Adjustment procedures (for nonresponse, coverage deficiencies, seasonal variations, etc.) also rely on assumptions/models. In such cases, the inaccuracy due to using models should be reported under the specific quality aspect.

Presentation of Accuracy Measures

Statistics with accuracy deficiencies may lead to fallacious conclusions if used uncritically. Knowledgeable users can avoid fallacies if appropriate accuracy measures are presented. Statistics with accompanying accuracy measures are more informative than "bare" statistics.

TIMELINESS

Many users want statistics from repeated surveys in order to monitor some specific development, prepared to take appropriate action if alarming levels are reached. In such situations a main requirement is that available statistics should be up to date. A vital aspect here is the time lag between now and the reference time for the last available statistics. This lag depends on how frequently the survey is repeated and its processing time. A user's quality judgement in this respect does not, however, solely depend on the maximal time lag; his/her opinion of the pace of change for the development under consideration is also crucial.

Statistics from repeated surveys are usually produced according to a regular scheme (monthly, quarterly, annually, etc.). In such situations it is natural to talk of *frequency* (or periodicity), including data collection frequency (the periodicity in the producer's data collection), reference-time frequency (the periodicity of reference times for published statistics), and dissemination frequency (the periodicity with which statistics are made public). Normally the three frequencies agree, but they can differ.

(Example: Swedish crime statistics are published quarterly, comprising statistics for each month in the quarter.) Users normally are most interested in reference time and dissemination frequencies.

Production time is the lag between the reference time point (or end of the reference period) and the time for publication of a statistic. Normally, the shorter the production time the better. However, if the statistics carry unpleasant messages, some users/actors may wish delayed publication. The common policy is that official statistics that do not have, or are late relative to, a promised publication date should be published as soon as they are ready.

Accuracy and production time may come into conflict with each other. Shortening of a production time often leads to increased nonresponse as well as more hasty editing, which in turn affect accuracy adversely.

Punctuality refers to the agreement between promised and actual dissemination time. Interest in punctuality varies considerably among users. An extreme example: For economic statistics that affect stock-market prices, punctuality may involve fractions of a second.

COHERENCE AND COMPARABILITY

Coherence relates to *sets of statistics*, and takes into account how well the statistics can be used together. Two subspects are of special importance. When the statistics set is a time series*, one speaks of *comparability over time*. When it comprises statistics for different domains with similar target characteristics, one speaks of *comparability over space*.

In comparison contexts one ideally wants to compare true values of the same characteristic. This ideal situation may not be achievable. As a second best, one wants to compare statistics with similar target characteristics and good accuracy.

When judging the similarity of target characteristics, their definitions (regarding units, population and domain delineation, variables, etc.) play a central role. The more stable a definition has been over time, the better comparability is over time. Analogously, for good comparisons over space, similarity in definitions of target

characteristics is crucial, *Statistical standard classifications* (e.g., those of the Nomenclature Générale des Activités Economiques dans les Communautés Européennes for the classification of industries) are vital to achieve agreement, or at least good similarity, between target characteristics.

The acuteness of comparisons also depends on the accuracy of the pertinent statistics, their bias and precision. If the statistics compared are severely inaccurate, observed differences may reflect "noise play" rather than true differences. Biases disturb comparisons, but the harm can be mitigated if the bias structures are similar. An important means for achieving good comparability is that statistics should be produced with a common, hopefully good, *methodology*, as regards questionnaire, data collection, and estimation; this will minimize bias and lead to similar bias structures. Common methodology is also important because the content/definition of a variable often depends upon the measurement and data collection procedures.

Comparability over Time

Surveys that are repeated over *time* yield *statistical time series*, which enable users to follow developments over time. Here one is concerned with the extent to which the statistics in a time series in fact estimate the "same thing" in the "same way." Stability over time of target characteristic definition and survey methodology work in the direction of good comparability over time.

Regarding stability of definitions, user interests may conflict. Users whose main interest is the present and future state of affairs want reality changes (e.g. changes in industry structure) to be met by appropriate changes in the statistics. But modifications of target characteristics to meet reality changes usually have adverse effects on comparability over time.

Certain users, notably those of statistics indicating short-term changes in economic activity, are anxious to be able to separate changes "in substance" from effects due to fairly regular seasonal variations. These users require *seasonal adjustments* and *calendar adjustments* as complements to tie basic time series.

Comparability over Space

A common usage of statistics is for the comparison of conditions in different geographical regions (e.g. average wages in different countries). The "space dimension" may also be of a nongeographical nature (example: comparison of average disposable incomes for families with 1, 2, 3, . . . children). Again, similarity of definitions of target characteristics and of survey methodology are crucial aspects.

When the statistics (for different domains) emanate from the same survey (by the same producer), problems regarding comparability over space are usually reduced to questions about the precision of the statistics. However, the farther apart the producers are (different surveys at the same agency, different agencies in the same country, offices in different countries, etc.), the greater are the comparability problems.

Coherence in General

Coherence relates to the feasibility of making joint use of statistics from different sources, not only for comparison purposes. (Example: In order to judge the consequences of a potential change in taxation and benefits rules, it might be of interest to combine statistics from an Income survey, an Expenditure survey, and a Rent survey. Then it is important that the statistics be coherent, for instance that the same definition of "household" be used in the different surveys.) There should be agreement in definitions of basic target characteristic quantities (units, population, domains, variables, and reference times).

AVAILABILITY AND CLARIFY

Forms of dissemination refer to what *dissemination media* (print on paper, diskette, CD-ROM, etc.) and what *distribution channels* are used.

Presentation refers to how statistics are presented in printed publications, databases, etc. Specifically it concerns the presence, layout, and clarity of texts, tables, charts, and other figures; referencing; etc. It also covers how well

particularly interesting features of the statistics are emphasized.

Documentation refers to users' ability to acquire documentation relating to published statistics. Most users want an easily readable quality declaration. More advanced users are often interested in precise documentation of the production process, which is particularly important when the user has access to micro data for personal use.

For that purpose, users may be interested in statistics that are not provided by the producer, but which can be derived from already collected micro data. There are two main options in this context.

The *producer* makes special derivations from available data, in accordance with requests formulated by the user.

The *user* obtains access to micro data for his/her own "statistics production."

Users with well-specified problems tend to prefer the first alternative. Important points are then how fast the derivations can be carried out, and at what cost.

Researchers are commonly interested in obtaining a micro data for their own processing. Thereby they can make analyses more flexibly, faster, and cheaper than via special derivations by the producer. Release of micro data is, however, associated with problems of secrecy, and special precautions have to be taken by the producer. Removal of the means of identification is a minimum requirement.

One main aspect of *information services* is what assistance a user can get to find his/her way in the "statistics storage." Another is the possibility of getting answers to questions about published statistics: their interpretation, specifics of definitions, details about data collection, etc.

SELECTED REFERENCES ON QUALITY WORK AT SOME STATISTICAL AGENCIES

Official statistics has a long tradition. It has developed considerably during this century due to new demands (e.g. as regards subject-matter

areas), new methodology (e.g. survey sampling), new technology (e.g. for data collection and processing), etc. The numbers of uses and users have increased greatly. To give a comprehensive review of the notion of quality of official statistics over time and space is too big a task to be covered here. We restrict ourselves to some recent milestones and a brief review of current views and activities.

Milestones

First, much survey development work has its origin in statistical agencies of the U.S. Federal Government, notably the Bureau of the Census*. The U.S. role in this development is described by Bailar [1] and by Fienberg and Tanur [7].

Second, works on quality issues by Statistics Canada are often cited by other agencies. An important example is *Quality Guidelines* [11], which is a manual "providing advice for the production, maintenance and promotion of quality for statistical processes." Related works [12, 13] focus on how to inform users.

Third, and not least, instrumental work has been carried out by international statistical organizations. The task of informing users was discussed in the 1980s by U.N. statisticians [16], who were influenced by work by Statistics Canada, Statistics Sweden, and U.S. Federal statistical agencies. The latter work is presented in Gonzales et. al. [8]. The UN guidelines emphasize two main types of quality presentations: (1) extensive presentations with technical orientation, written for professional statisticians, and (2) presentations for statistics users in general, to assist them in interpretation of the statistics and in deciding whether, and how, to use them.

Some Current Views and Activities

Only a few papers discuss the quality concept in such structural detail as here; Statistics Sweden and Eurostat are two exceptions. However, quality concepts emerge implicitly from papers on quality endeavors. We try to emphasize these aspects in the review below.

Statistics Sweden* [15] presents a definition of quality and recommendations for statements on quality. This document updates 1979 guidelines for presentations on the quality of statistics and a 1983 policy for a user-oriented presentation.

Eurostat has an internal quality policy document, drafted in 1996. Moreover, there are documents on the quality of business statistics, tied to regulations on business statistics [5].

Harmonization and coordination of statistical systems are important in work that is aimed at good comparability and coherence of international statistics. These quality components are emphasized in the UN guidelines and in the Eurostat quality concept for business statistics. The U.N. System of National Accounts is an important example of a world-wide harmonized system, which also influences other branches of economic statistics. Beekman and Struijs [2] discuss economic concepts and the quality of the statistical output.

Statistisches Bundesamt [14] provides a compendium of discussions on the quality of statistics from a user's point of view, for political decision makers, scientists, in econometric uses, etc. Quality components that recur in several discussions are timeliness, accuracy, and comparability.

Dippo [4] considers survey measurement: and process improvement. The paper links early work on nonsampling errors and different components of the overall error with recent work on process improvement. It includes the quality measurement model—which has the user at the center-of the U.S. Bureau of Labor Statistics*.

McLennan [10] describes the history of British official statistics and developments in the 1990s, and lists some operational principles for the U.K. Central Statistical Office (CSO) under three headings: "definitions and methodology," "integrity and validity of CSO output," and "timing and coverage of publications."

Linacre [9], when describing the methodology followed in a statistical agency, refers to the objectives of the Australian Bureau of Statistics as "informed and satisfied clients through an objective, relevant, and responsive statistical system." A statistical product should comprise "reliable, timely, and coherent statistics."

Characteristics of an effective statistical system are discussed by Fellegi [6], who states that the "objective of national statistical systems is to provide relevant, comprehensive, accurate, and objective (politically untainted) statistical information."

Colledge and March [3] report on a study, comprising 16 national statistical agencies around the world, on the existence of "quality practices" (classified as policies, standards, guidelines, and recommended practices) as well as the degree of compliance with prescribed practices.

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