Conference on Data Quality for International Organizations

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FAO Statistical Data Quality Framework: A multi-layered approach to monitoring and assessment

Submitted by Food and Agriculture Organization of the United Nations, Rome, Italy[1]

Background

Since the early 1990's, the FAO Statistics Division has been developing data quality frameworks and concepts relating to agricultural statistics. The initial work outlined in the paper by Trant (1993), focused on the concepts of accuracy, relevance and timeliness of a statistical estimate. It also discussed the need for sound statistical metadata in order for the user to be able to interpret the statistics. This approach was primarily aimed at national statistical offices and the need to make them accountable for data they publish. This work provided the following framework for data quality assessment: Concepts and methods; Quality assurance; Reference period; Error; Coverage; Response rates; Editing and imputation effect or rate; Comparability over time; Revisions; Comparability with data from other sources.

More recently, the FAO Statistics Division has begun using a data quality dimensions very similar to that of Eurostat (2000): Relevance; Accuracy; Timeliness and Punctuality; Accessibility and Clarity; Comparability; Coherence and Completeness; Sound Statistical Metadata. In addition to the core Eurostat concepts/dimensions a statistical metadata component was included. The statistical metadata component has been consolidated under the Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics project (ABCDQ) which focuses on national agricultural data that comes into the FAO Statistics Division.

This paper provides an overview of the work in the FAO Statistics Division on data quality and details on the FAO Statistical Data Quality Framework which will provide a multi-layered approach to data quality evaluation and monitoring.

A multi-layered approach

After reviewing the earlier work undertaken in FAO, a more comprehensive data quality evaluation and monitoring framework was developed. The approach is based on monitoring data quality at these points in the statistical process (q_1, q_2, and q_3), as well as the change in data quality between points q_1 and q_2 and between points q_2 and q_3 (see figure 1).

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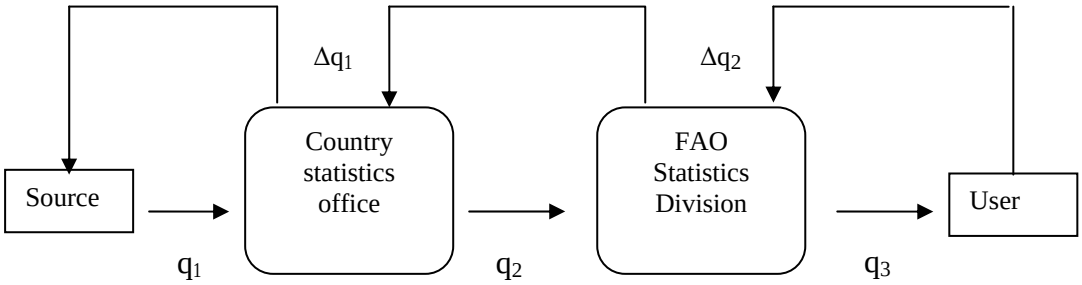
Figure 1. FAO data quality monitoring data quality at points in the statistical process



The key aspect to this approach to data quality evaluation and monitoring is the focus on three different points of the statistical process: monitoring data quality at points q1, q2 and q3. Currently, international organizations generally focus on just one point of the statistical process and therefore do not take full advantage of information on data quality available at various points in that process. This is the case with both the IMF's Data Quality Assessment Framework (DQAF July 2003) and Eurostat's quality definition (2000) approach. A review by IMF and Eurostat (2004) of their approaches to data quality noted that evaluation is completed by national statisticians' self-assessment of quality, with the focus on quantitative measurements. According to that review, the IMF's assessment of quality has "largely been performed by IMF staff through the Report on the Observance on Standards and Codes. Using the DQAF as benchmark, the assessment is conducted using a four-part scale that ranges from 'observed' to 'not observed' by comparing national practices against internationally accepted practices."

By monitoring data quality at the three key points it is possible to assess value added by each stage of the process and assess performance. The third major benefit to this approach is that it will be possible to identify and address data quality problems throughout the statistical process. As can be seen in Figure 1, feedback loops are incorporated to provide a mechanism for improving data quality.

Monitoring data quality at point q_1

Monitoring data quality at the source is essential in order to identify a benchmark of quality for the data series. Point q_1 is the point before data is processed (edited/validated) by the national statistical agencies. It is common practice in national statistical systems to provide basic information on the quality of the data collection device and data, whether it is a survey, census, administrative records or other data collection process. FAO's Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics project (ABCDQ) aims to produce data quality information at point q_1 in the FAO Data Quality Assessment Framework.

Monitoring data quality at point q_2

Once the data has been processed by the national statistics agency, an evaluation of the quality that is disseminated or used by the agency is essential. As noted by the United Nations (2003), "Professional statisticians and reputable statistical institutions are obligated to describe accurately and openly the strengths and weaknesses of the data they publish and explain how much inference the data can support. Although there is no international

consensus on how this should be accomplished, the statistical agency must be sure that its audience is properly informed regarding the following:

- Where data are located, according to subject and time period;
- How the data were defined and compiled;
- What quality is assigned to the data;
- What related data can be used for comparison or to provide context."

By monitoring points q_1 and q_2, a national statistical agency can assess value added by each stage of the processes, and produce estimates of Δq_1 and assess performance. The IMF's DQAF and the Definition of Eurostat both target point q_2 in the FAO Data Quality Assessment Framework.

Monitoring data quality at point q_3

International statistical agencies add quality and value to national statistical data in various ways. It can involve the actual improvement of national data (via data editing/validation), by providing context or providing internationally comparable data series. An example of the improvement of national data is found when international statistical offices process national merchandise trade statistics. When trade data is missing from a given country for a commodity, it is often possible to use the mirror statistics from the counter-party country (importer or exporter) to estimate the missing commodity data.

When an international statistical agency disseminates data (point q_3), it can assess value added by each stage of the process, produce estimates of Δq_2 and assess performance. The OECD's Quality Framework targets point q_3 in the FAO Data Quality Assessment Framework.

Data quality dependencies at points q_1, q_2 and q_3

As statistical data flows and is processed at the various stages of the statistical system, the data quality at each stage is a function of the inherited data quality from previous stages. As can be seen from Figure 1, the data quality the user receives at point q_3 is a function of the data quality of points q_2 and q_1. The same situation applies to the data received by an international national statistical agency at point q_2. The data quality at point q_2 is a function of the data quality inherited from point q_1.

Indicators of data quality used by international statistics agencies

A variety of indicators of statistical indicators are used by the international statistical agencies to measure the quality concepts/dimensions (see Annex1). Whilst the indicators tend in general to cover the same concepts, currently there is little quantitative evaluation of data series. In the FAO Statistics Division, data quality assessment indicators in the ABCDQ are an initial attempt at providing some qualitative and quantitative evaluation of data series.

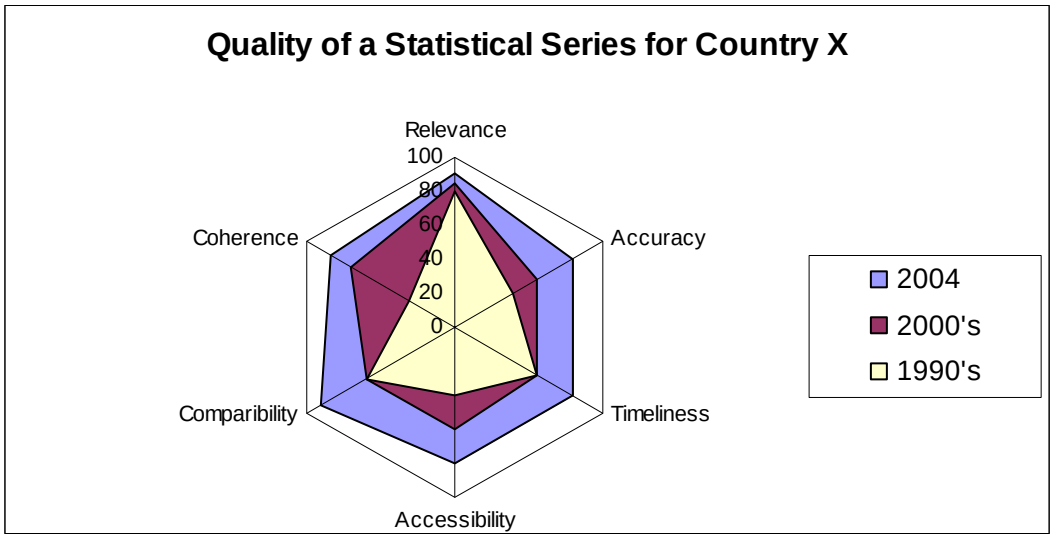
One major concern with the data quality concepts and indicators used by international statistical agencies is that they assume equal weighting in terms of evaluation of data quality within a particular statistical series, when it would be more appropriate to apply

different weights to the concepts and indicators. For example, take the standard Eurostat Quality Definition: Relevance; Accuracy; Timeliness and Punctuality; Accessibility and Clarity; Comparability; Coherence it is difficult to justify their being equal weighting for all dimensions.

A related problem is that of the trade-off between timeliness and accuracy (was identified by the European Central Bank (2001)). It is important for the statistical agency to provide a clear statement of the value put on each dimension and how this is applied in the evaluation of data quality.

The FAO Data Quality Assessment Framework provides a method of summarizing statistical data quality over a number of dimensions. Figure 2 provides an example using the Eurostat Quality Definition. This approach allows for a clear summary of the data quality to be presented and can be extended over a number of time periods, therefore allowing for measurement of points Δq_1 and Δq_2.

Figure 2. Summarizing the data quality of a statistical series over time

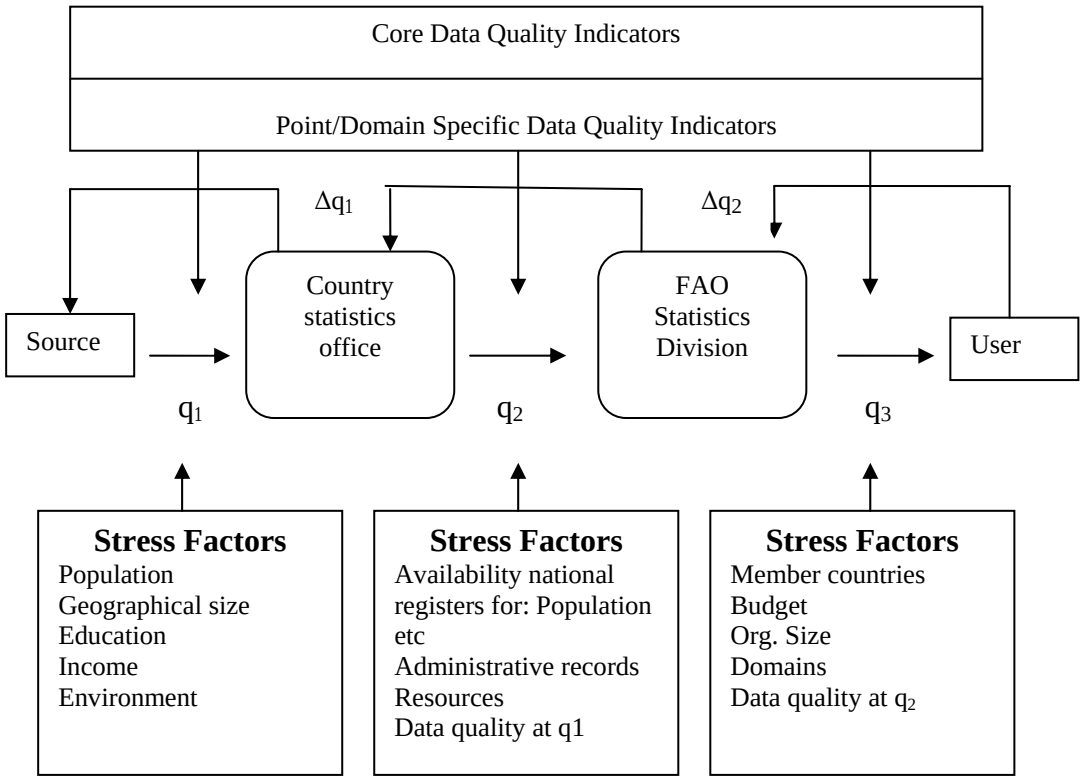


The difficulty concept (stress factors) and data quality deflators

When we ask countries-regardless of size, population, level of development to provide statistical data and evaluate them on quality concepts (such as relevance, accuracy, timeliness and punctuality, accessibility and clarity, comparability and coherence), we are not providing a level playing field for evaluation. Some specific data series are harder for some countries to collect and process than for other countries and this should be indicated in the evaluation. For example, a developing country that is very large both geographically and has a large population is less likely to be able to perform an agricultural census as often as a smaller, more developed country. It would therefore be hard to justify a comparison of these two countries using the same standard data quality criteria.

Figure 3 provides an overview of the points in the overall data quality framework where stress factors interact with the ability of national or international statistical agencies to perform their functions. The data quality indicators at points q_1, q_2 and q_3 are functions of the stress factors at those stages of the statistical process. For example, the output data quality indicators for an international statistical agency with over 200 member countries, a limited budget, a small staff and a large number of statistical domains to manage would need to take into account those specific stress factors when performance is evaluated. Countries also have similar stress factors, but these are related to their level of development.

Figure 3. FAO Statistical Data Quality Framework - stress factors and data quality indicators at points q_1, q_2 and q_3



Due to the various stress factors, a deflator to the standard data quality indicators needs to be applied in order to provide the basis for comparison between countries or between international statistical agencies. Deflator concepts in data quality needs to be developed and systematically applied on these evaluations. Possible deflators could include, GNP per capita, population, size of country (sq kms.), population density, etc.

Statistical agency performance - absolute and relative data quality

Data quality should also be considered in absolute and relative terms with reference to the performance of the statistical agency. The performance of a statistical agency that is operating under high stress factors in the production of statistical data should not be measured

in absolute terms compared to other statistical agencies. Absolute measures of data quality are more applicable for comparison within a statistical agency.

Core data quality indicators at points q_1, q_2 and q_3

The data quality indicators used at points q_1, q_2 and q_3 and the weights given to them, will vary as the criteria used will change at each of these measurement points. For example, at point q_3, the user is more interested in the quality dimensions of timelines and punctuality and the related indicators than in accuracy indicators such as unit response rates, editing rates and ratios (which are more relevant at points q_1 and q_2). Core data quality indicators need to be developed for measurement at point q_1, q_2 and q_3. These core data quality indicators would then be used to provide the linkage between the stages in the statistical process and calculation of the change in data quality: points $\Delta q1$ and Δq_2.

Essential statistical information

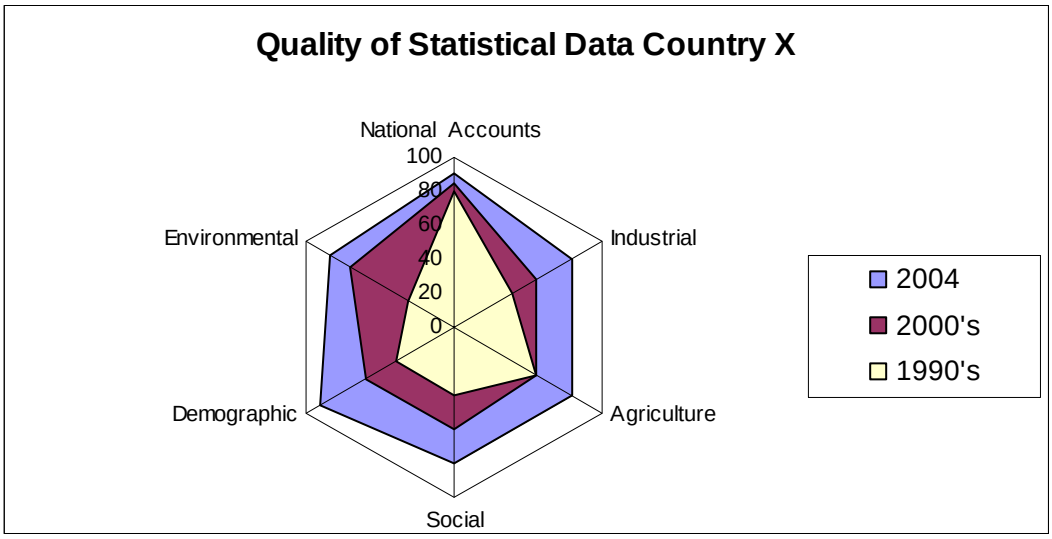
A pre-requisite to evaluations of the data series disseminated by countries is for essential basic statistical information to be collected and disseminated according to the United Nations (1994) Fundamental Principles of Official Statistics. Annex 2 provides a listing of countries and areas during the 1990 and 2000 rounds for the World Census of Agriculture and Population and Housing Census that have undertaken a population or housing census, but not an agriculture census (a total of 136 countries and areas (former or current)). Whilst a number of these countries and areas have either little or no agriculture or have other methods of collecting bench-mark data, many developing countries do not. We therefore do not have bench-mark data for those countries and therefore concerns should be raised about the reliability of data they supplied. The same principal could also be applied to population censuses: a default low level of quality being applied to data disseminated by countries who have not been able to perform a population census over the past two census rounds.

A related issue is that of the essential data quality dimensions. If a country has high scores for its data on relevance, accuracy, timeliness and punctuality, comparability and coherence, but does not make the data available/accessible, then it is hard to defend any data quality value being given to their data. The data quality dimension of accessibility should be considered an essential element in any data quality assessment: if data is not accessible then it has little or no value, even if it has high levels of data quality on the other dimensions.

Data quality trade-offs

Countries do not have the luxury of being able to put all the resources they would like all the time into all statistical domains. Trade-offs have to be made between allocation of resources to the various statistical domains. The data quality concept can be applied to monitor these trade-offs and show the influence that the allocation of resources can have on the various statistical domains. Figure 4 provides an example of how this could be applied. The summary data quality for a statistical domain (national accounts, agriculture, etc) could be monitored and used for planning purposes in the national or international statistical agency.

Figure 4. Summarizing the data quality of a statistical agency over time



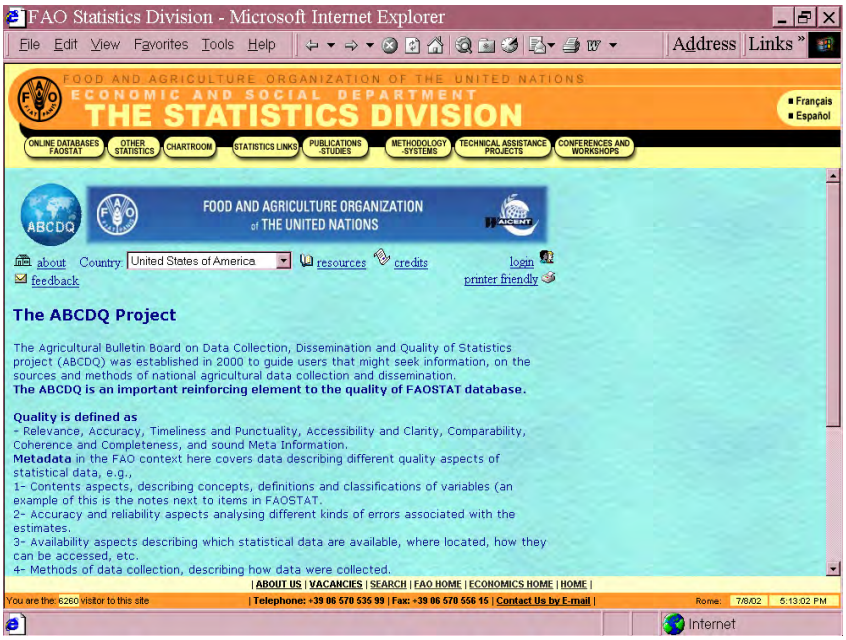
FAO's Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics project (ABCDQ)

The FAO ABCDQ project (Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics) was established in 2000 to provide statistical metadata, on the sources and methods of national agricultural data collection and dissemination. It aims to produce data quality information at point q_1 in the FAO Data Quality Assessment Framework.

Metadata in the FAO context here covers data describing various quality aspects of statistical data, e.g:

- Content aspects describing concepts, definitions and classifications of variables. Accuracy and reliability aspects analysing different kinds of errors associated with estimates.
- Availability aspects describing which statistical data are available, where they are located, how they can be accessed, etc.
- Methods describing how data were collected.

Figure 5. Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics project (ABCDQ)



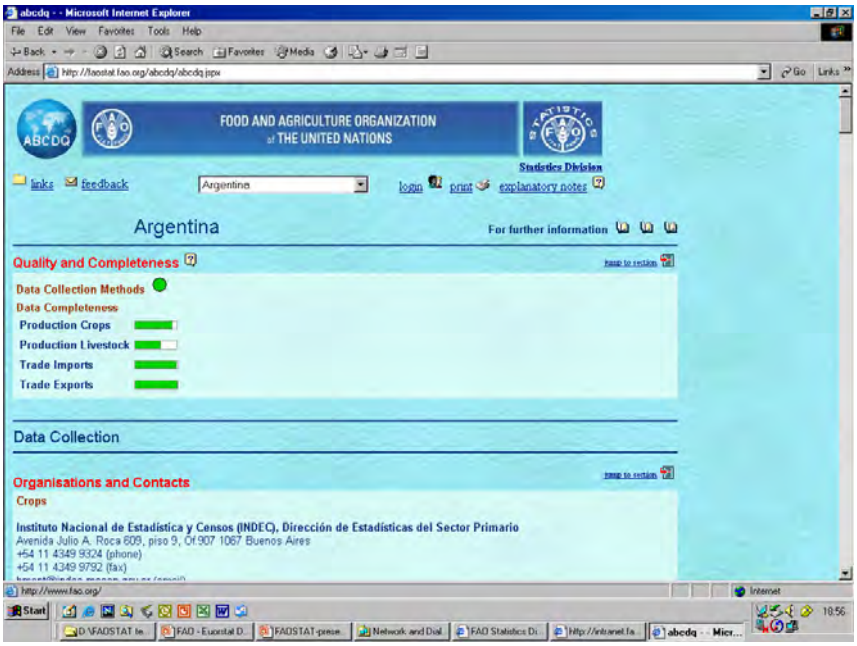
Data quality indicators in FAO's ABCDQ

The data quality assessment provides a guide to the relevance, accuracy, timeliness, punctuality, accessibility, clarity, comparability, coherence, completeness and sound metadata available to support the data from countries. Data and the methods used to collect the data are subjectively assessed by experts in the specific statistical domain. Countries are then allocated a colour code based on the assessment, with a Green code reflecting high standards of data quality, an Amber code reflecting medium standards of data quality. A Red code is given where there are low standards of data quality or where little or no information is available to assess data quality. Countries are encouraged to contact the FAO Statistics Division and provide detailed metadata to assist data users in understanding their data, improve where the overall data quality and quality assessment and make any adjustments or re-classifications where necessary.

A Country Data Completeness indicator for the FAOSTAT database provides the user with indicators of the availability of official data for the past four years. The indicator (presented as a barometer) is calculated for crops and livestock production as well as agricultural trade (export and import). Different algorithms are applied for each area. The general algorithm used is as follows:

1. The top 15 commodities (based on the total of the years last four years) were identified. Countries with less than 15 commodities were not be negatively influenced while calculating the completeness indicator.
2. The data source symbols for these commodities are used as the weights and a weighted average is calculated for each country.
3. Completeness = 100 * symbol weights / symbol counts.

Figure 6. Agricultural Bulletin Board on Data Collection, Dissemination and Quality of Statistics project (ABCDQ) - Data Quality Assessment Indicators



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Annex 1.

Quality indicators and frameworks of selected international Organizations

Eurostat

Quality aspects	Indicators
Relevance (Completeness merged with relevance)	R1. User satisfaction index R2. Number of publications disseminated and/or accesses to databases CP1. Rate of available statistics
Accuracy	A1. Coefficient of variation (CV) A2. Unit response rates A3. Item response rates A4. Editing rates and ratios A5. Imputation rates and ratios A6. Over-coverage and misclassification error rates A7. Average size of revisions
Timeliness and Punctuality	T1. Punctuality of time schedule of effective publication T2. Average time between the end of reference period and the date of the first results T3. Average time between the end of reference period and the date of the final results
Accessibility and Clarity	AC1. Number and types of means used for disseminating statistics
Comparability (refers to cross country)	C1. Number and proportion of differences in concepts or/and measurement from the European norms C2. Number and length of comparable time series C3. Asymmetries for statistics mirror flows
Coherence (comparability over time or over datasets)	CH1. Number and proportion of sets of statistics that satisfies the requirements for the main secondary use

IMF (DQAF)

Source: http://dsbb.imf.org/vgn/images/pdfs/dqrs_Genframework.pdf

Quality dimensions & elements	Indicators
0 Prerequisites of quality 0.1 Legal and institutional environment	0.1.1 The responsibility for collecting. processing. and disseminating statistics is clearly specified 0.1.2 Data sharing and coordination among data producing agencies

	are adequate 0.1.3 Respondents' data are to be kept confidential and used for statistical purposes only 0.1.4 Statistical reporting is ensured through legal mandate and/or measures to encourage response
0.2 Resources	0.2.1 Staff. financial. and computing resources are commensurate with statistical programs 0.2.2 Measures to ensure efficient use of resources are implemented
0.3 Relevance	0.3.1 The relevance and practical utility of existing statistics in meeting users' needs are monitored.
0.4 Other quality management	0.4.1 Processes are in place to focus on quality. 0.4.2 Processes are in place to monitor the quality of the collection processing and dissemination of statistics 0.4.3 Processes are in place to deal with quality considerations including tradeoffs within quality. and to guide planning for existing and emerging needs
1. Assurance of integrity	
1.1 Professionalism	1.1.1 Statistics are compiled on an impartial basis 1.1.2 Choices of sources and statistical techniques are informed solely by statistical considerations 1.1.3 The appropriate statistical entity is entitled to comment on erroneous interpretation and misuse of statistics
1.2 Transparency	1.2.1 The terms and conditions under which statistics are collected. processed. and disseminated are available to the public 1.2.2 Internal governmental access to statistics prior to their release is publicly identified 1.2.3 Products of statistical agencies/units are clearly identified as such 1.2.4 Advance notice is given of major changes in methodology. source data. and statistical techniques
1.3 Ethical standards	1.3.1 Guidelines for staff behaviour are in place and are well known to the staff.
2. Methodological soundness	
2.1 Concepts and definitions	2.1.1 The overall structure in terms of concepts and definitions follows internationally accepted standards. guidelines. or good practices
2.2 Scope	2.2.1 The scope is broadly consistent with internationally accepted standards. guidelines. or good practices
2.3 Classification / Sectorization	2.3.1 Classification / sectorization systems used are broadly consistent with internationally accepted standards. guidelines. or good practices
2.4 Basis for recording	2.4.1 Market prices are used to value flows and stocks 2.4.2 Recording is done on an accrual basis 2.4.3 Grossing/netting procedures are broadly consistent with

	internationally accepted standards. guidelines. or good practices
3. Accuracy and reliability	
3.1 Source data	3.1.1 Source data are obtained from comprehensive data collection programs that take into account country-specific conditions 3.1.2 Source data are consistent with the definitions. scope classifications. valuation. and time of recording required 3.1.3 Source data are timely
3.2 Assessment of source data	3.2.1 Source data – including censuses. sample surveys and administrative records – are routinely assessed. e.g.. for coverage sample error. response error. and non-sampling error; the results of the assessments are monitored and guide statistical processes
3.3 Statistical techniques	3.3.1 Data compilation employs sound statistical techniques to adjust data sources 3.3.2 Other statistical procedures (e.g.. data adjustments and transformations. and statistical analysis) employ sound statistical techniques
3.4 Assessment and validation of intermediate data and statistical outputs	3.4.1 Main intermediate data are validated against other information where applicable 3.4.2 Statistical discrepancies in intermediate data are assessed and investigated 3.4.3 Statistical discrepancies and other potential indicators of problems in statistical outputs are investigated
3.5 Revision studies	3.5.1 Studies and analyses of revisions are carried out routinely and used to inform statistical processes
4. Serviceability	
4.1 Periodicity and timeliness	4.1.1 Periodicity follows dissemination standards 4.1.2 Timeliness follows dissemination standards
4.2 Consistency	4.2.1 Statistics are consistent within the dataset (e.g.. accounting identities observed) 4.2.2 Statistics are consistent or reconcilable over a reasonable period of time 4.2.3 Statistics are consistent or reconcilable with those obtained through other data sources and/or statistical frameworks
4.3 Revision policy and practice	4.3.1 Revisions follow a regular. well-established and transparent schedule 4.3.2 Preliminary data are clearly identified 4.3.3 Studies and analyses of revisions are made public
5. Accessibility	
5.1 Data accessibility	5.1.1 Statistics are presented in a way that facilitates proper interpretation and meaningful comparisons (layout and clarity of text. tables. and charts) 5.1.2 Dissemination media and format are adequate 5.1.3 Statistics are released on a pre-announced schedule 5.1.4 Statistics are made available to all users at the same time 5.1.5 Statistics not routinely disseminated are made available upon

	request
5.2 Metadata accessibility	5.2.1 Documentation on concepts. scope. classifications. basis of recording. data sources. and statistical techniques is available. and differences from internationally accepted standards. guidelines or good practices are annotated 5.2.2 Levels of detail are adapted to the needs of the intended audience
5.3 Assistance to users	5.3.1 Contact person for each subject field is publicized 5.3.2 Catalogs of publications. documents. and other services including information on any charges. are widely available

OECD Quality Framework

Source: http://www.oecd.org/document/43/0.2340.en_2825_293564_21571947_1_1_1_1.00.html

Quality dimensions	Definition
Relevance	The relevance of data products is a qualitative assessment of the value contributed by these data. Value is characterized by the degree to which the data serves to address the purposes for which they are sought by users.
Accuracy	The accuracy of data products is the degree to which the data correctly estimate or describe the quantities or characteristics they are designed to measure. OECD context: Accuracy of the data is largely determined by the accuracy of the data received from the contributing organizations. On the other hand. the activities carried out by OECD can influence the overall accuracy.
Credibility	The credibility of data products refers to the confidence that users place in those products based simply on their image of the data producer. i.e.. the brand image. Credibility is determined in part by the integrity of the production process. OECD context: publishing bad quality data received from countries affects the overall credibility of the OECD. Furthermore. once agreement between the OECD and countries has been reached on collection of specified data. the data subsequently collected cannot be withdrawn in response to political pressure.
Timeliness	The timeliness of data products reflects the length of time between their availability and the event or phenomenon they describe. but considered in the context of the time period that permits the information to be of value and still acted upon.
Accessibility	The accessibility of data products reflects how readily the data can be located and accessed from within OECD data holdings. OECD context: internal and external users might have quite different perceptions of accessibility because of the differences in access methods.
Interpretability	The interpretability of data products reflects the ease with which the user may understand and properly use and analyse the data. The range of different users leads to such considerations as metadata presentation in layers of increasing detail. The adequacy of the definitions of concepts. variables. and terminology. information describing the limitations of the data etc.
Coherence	Reflects the degree to which data are logically connected and mutually

	consistent. Distinction can be made between coherence within a dataset. coherence across datasets. coherence over time and coherence across countries. Ensuring coherence across countries is one of the major sources of value added provided by the OECD.
(Cost-efficiency)	The cost-efficiency with which a product is produced is a measure of the costs and provider burden relative to the output. Whilst the OECD does not regard cost-efficiency as a dimension of quality. it is a factor that must be taken into account in any analysis of quality as it can affect quality in all dimensions.

Annex 2

Summary of World Census of Agriculture and Population and Housing Census by countries and areas during 1990 and 2000 rounds

The following countries and areas performed a Population and Housing Census, but not an Census of Agriculture during the 1990 or 2000 round

Afghanistan; Andorra; Angola; Anguilla; Armenia; Aruba; Azerbaijan; Belarus; Bermuda; Bosnia Herzegovina; British Virgin Islands; Brunei Darussalam; Bulgaria; Burundi; Cambodia; Cameroon; Cayman Islands; Chad; Channel Islands – Guernsey; Channel Islands – Jersey; China – Hong Kong SAR; China – Macao SAR; Comoros; Costa Rica; Croatia; Cuba; Dominican Republic; El Salvador; Equatorial Guinea; Eritrea; Faeroe Islands; Falkland Islands (Malvinas); French Polynesia; Gabon; Georgia; Ghana; Gibraltar; Greenland; Guyana; Haiti; Indonesia; Iceland; Iraq; Isle of Man; Kazakhstan; Kiribati; Korea. Democratic People's Republic; Kuwait; Kyrgyzstan; Liberia; Liechtenstein; Lithuania; Macedonia. the Former Yugoslav Rep.; Malaysia; Maldives; Mali; Marshall Islands; Mauritius; Micronesia. Fed. States of; Moldova. Republic of; Monaco; Mongolia; Montserrat; Nauru; Netherlands Antilles; Nigeria; Norfolk Island; Occupied Palestinian Territory; Papua New Guinea; Pitcairn; Russian Federation; Saint Helena ex. dep.; St. Pierre and Miquelon; San Marino; Serbia and Montenegro; Singapore; Solomon Islands; Somalia; South Africa; Sudan; Svalbard and Jan Mayen Island; Syrian Arab Republic; Tajikistan; Timor-Leste; Tokelau; Tunisia; Turkmenistan; Turks and Caicos Islands; Tuvalu; Ukraine; United Arab Emirates; Uzbekistan; Viet Nam; Wallis and Futuna Islands; Western Sahara; Yemen Arab Republic (former). Yemen Democratic (former); Zimbabwe.

Source:

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