

## **QUALITY MEASUREMENT AND REPORTING IN THE UK OFFICE FOR NATIONAL STATISTICS**

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### **ABSTRACT**

The paper discusses the ONS approach to developing systematic quality measurement and reporting. This is presented against the background of European developments and growing demand for quality measurement. Measuring the quality of statistics presents considerable practical and methodological challenges. The paper describes the main building blocks for the new quality measure programme, with specific examples. Working with other NSIs, developing an enhanced measurement framework and developing process and output measurement and reporting, are all vital ingredients to achieving recognition of the ONS as a quality organisation.

KEY WORDS: quality, measurement, quality reporting.

### **1. INTRODUCTION**

Measuring and reporting on the quality of statistics is a complex undertaking. There are several dimensions to the concept of quality and many factors potentially impact on the quality of statistics. Typically there are no comprehensive measures of quality. Just as the need for statistics vary between different users or user groups, so do their needs and priorities vary between different dimensions of quality and over time. There is a growing demand for meaningful quality measures which are communicated to users in a way which they can understand and which meet their needs. This requires taking into account all National Statistics Institutes(NSIs) outputs and measuring quality not only for estimates based on sample surveys, but also for complex statistics and analyses, including those based on a combination of different types of sources, including administrative data.

This paper describes the approach being taken within the ONS to improve quality measurement and reporting within a quality measurement programme. The paper describes the key drivers for quality measurement of ONS outputs and describes the main building blocks for the quality measurement programme, with specific examples.

### **2. DEMAND FOR QUALITY MEASUREMENT**

As already stated the users of official statistics and their demands for quality are very varied. For the ONS some of the key drivers for quality measurement are as outlined in this section.

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## UK NATIONAL STATISTICS<sup>4</sup>

A Framework for UK National Statistics (ONS, 2000) was launched in June 2000. The core values are quality, efficiency and public confidence in UK National Statistics. The Framework sets out the aims and objectives for National Statistics, one of the key objectives is “**to improve the quality, timeliness and relevance of its services to customers both within government and the wider community**”. The draft Code of Practice sets out the professional standards and principles that will apply to National Statistics so that users can focus on what the statistics say rather than how the statistics were produced. One of the key principles is that **quality standards for National Statistics will be set and reported on, and quality measures will be regularly available, as statistics are released.**

### ONS OBJECTIVES

As a quality organisation, the ONS needs to measure and report on quality of its outputs and recognise that process measurement is vital to achieving quality in all stages during the production of statistics. Effective and systematic measurement is essential to achieving and demonstrating continuous improvement.

### UK STATISTICS COMMISSION

Quality measures for UK National Statistics are also of considerable interest to the UK Statistics Commission. The Statistics Commission has been set up as part of the National Statistics Framework in order to provide independent, reliable and relevant advice on National Statistics and an additional safeguard on the quality and integrity of National Statistics.

### EUROPE

There is an increasing demand for quality measures and indicators to be included with the transmission of data to Eurostat. For example, for the Structural Business surveys the current emphasis is on providing accuracy measurements in the form of coefficients of variation and response rates, while for short-term businesses the quality report being developed asks for quality indicators across the full range of data quality attributes. Other recent European legislation also covers quality reporting (for example, there is a specific Commission Regulation on quality reporting for the Labour Cost Survey).

A strategic initiative has been put in place since 1999, with the creation of a European Expert Leadership Group on Quality (LEG). The LEG has recently completed its work, producing a final report containing 22 recommendations for future quality management developments within the European Statistical System (ESS). Specifically the LEG recommended that each NSI should report quality using the agreed ESS dimensions of data quality (relevance, accuracy, timeliness, accessibility, comparability, coherence and completeness). It also recommended that NSIs within the European Union (EU) should report product quality according to these dimensions and that the measurability of each quality dimension should be improved. There were a number of recommendations that covered the sharing of good practice of methods, statistics production, information management and dissemination practices. The LEG also recognised the importance of process quality and has recommended that a handbook on the identification of key process variables, their measurement and measurement analysis should be developed. It recommended that each ESS member should develop training for their staff in quality work. To assist in the sharing of good practice a biennial conference covering any methodological and quality-related topics of relevance to the ESS has been proposed and a biennial quality award for official statistics has been established.

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<sup>4</sup> In the UK, National Statistics are produced by staff working both in the Office for National Statistics (ONS) and in other government departments and agencies under the UK devolved statistical system. The term 'NS' refers to the collective set of outputs produced within this system. All public access databases and publications produced by ONS and many key public interest statistics produced by other government departments are included.

### **3. APPROACH TO QUALITY MEASUREMENT**

To meet these demands for quality information the ONS is developing a quality measurement programme. An early stage of this programme will be to build on the framework for data quality that has been developed by the European Statistical System(ESS).

#### **DATA QUALITY FRAMEWORK**

The agreed data quality attributes within this framework are :

Relevance: concepts, measurements and statistical products reflecting user needs;

Accuracy: usually measured as the average distance between the true parameter value and the statistical estimate;

Timeliness and punctuality in disseminating results: responsiveness to user needs;

Accessibility and clarity of results: results accessible in a user-friendly manner. Users provided with information about the quality of the statistics and about methods used to derive the figures;

Comparability: allowing reliable comparison over time and space;

Coherence: consistent standards

Completeness: coverage reflecting user need.

Within this framework, accuracy and timeliness are generally considered to be a key measure of quality. There are considerable practical and methodological difficulties in measuring some of the components of the quality attributes vector. Some can only be measured qualitatively or only in part. In the case of accuracy it is rarely possible to measure all the components of non-sampling error, such as frame errors, measurement errors, processing errors, non-response errors and model assumption errors. Process quality measures need to be incorporated into the framework – for example, whereas non-response bias is the desired measure in practice the response rate is used instead.

#### **QUALITY MEASUREMENT PROGRAMME OUTCOMES AND OBJECTIVES**

The desired outcome of this programme will be that users have access to a full range of quality measures and indicators so that they are able to understand the strengths and limitations of official statistics and to use them appropriately. The availability of comprehensive quality measures will also be used within ONS to monitor improvement and to provide support to implementing changes to achieve continuous improvement.

To achieve this outcome the quality measurement programme will have a number of key objectives. In the first place the ONS will be reviewing current practice of quality measurement, both in terms of the methodology used and to assess the current quality of ONS outputs. The second step will be to use the ESS agreed framework and enhance it by incorporating additional quality measures and indicators, including process quality measurement. The review of current practice, with the enhanced framework, will be used to identify areas where new measures are needed and for planning the development of the methods and tools needed to produce these measures on a consistent basis. As well as developing methods to measure quality it is recognised that it is important to develop guidance and standards for methods and the reporting of quality measures. There will also be the need to develop different strategies for the reporting of quality measures to different groups of users, ranging from the general public to analytic users and key stakeholders.

### **4. BUILDING BLOCKS FOR IMPROVEMENT**

There are a number of elements that will be vital ingredients to the achievement of ONS being recognised as quality organisation. Some of these are already in place and others are under development. The quality measurement programme aims to bring this work together and ensure that quality is measured and reported

in a consistent manner and current practice is shared throughout ONS. Therefore, it will be important to develop an effective communication strategy so that all staff within the ONS are aware of the programme and that the programme encompasses all the quality measurement initiatives. This section of the paper gives an outline of the elements that are currently being developed.

## **CONSULTING WITH OTHER NSIS**

In defining quality measures and indicators and in developing the new framework the contacts with other NSIs and learning from their experiences will be very valuable. This is relevant both in the European context and more widely. Within the EU, the Eurostat – led implementation of the recommendations of the EU Quality LEG, as described in section 2, will include actions to develop quality measurement. A specific Working Group has already been set up with the mandate, to harmonise the definition of quality in statistics, to standardise quality reports, to address methodological problems for measuring the quality of statistics, to co-ordinate all activities related to quality within Eurostat and the NSIs.

## **SELF-ASSESSMENT: EFQM MODEL**

One of the recommendations from the work of the European Quality LEG is that a systematic approach to quality improvement should be adopted and that the EFQM excellence model should be used as a basis for this work. The EFQM is a non-prescriptive framework that recognises that there are many approaches to achieving sustainable excellence. The model's framework is based on nine criteria: five 'enablers' (leadership, people, policy and strategy, partnerships and resources, processes), i.e. what the organisation does and how it does it; and four 'results' (people, customer, society, key performance), i.e. what the organisation achieves. 'Results' are caused by 'enablers'. This model will be incorporated into the ONS quality strategy, and will provide an overall framework for self-assessment. As part of the quality measurement programme there will be a need to assess the quality measures currently available, to identify any gaps in measurement and develop any new measures needed to implement this assessment tool throughout the ONS.

## **ANALYSIS OF CURRENT PROCESSES**

A standard form of process documentation has been developed within the UK National Statistics. The documentation, which is in the form of a questionnaire, covers all activities involved in producing statistics, from defining the requirement through to evaluating the results. The self-assessment questionnaire is intended to be used in the context of developing plans to improve the quality of the statistics concerned. Answering the questions helps identify the strengths and weaknesses of the processes involved, both providing evidence of good practice and stimulating ideas for improvements. The completed questionnaires fulfil the following purposes:

- they provide improved documentation for each chain of activity leading to a National Statistics output;
- they help statisticians identify areas for improvement within the processes they manage, particularly by reference to good practice systematically described in other templates;
- they support the National Statistician in his role of assuring quality across National Statistics;
- they build confidence among external stakeholders, such as major users and the Statistics Commission, in our approach to quality.

The completed questionnaire is seen primarily as a management tool for local use by the producers of statistics. It is not intended for the users of the statistics, for whom other documentation will be more appropriate.

Details of the areas covered by the questionnaire are shown below in the box below. Not all areas will be appropriate to all processes.

## **ANALYSIS OF CURRENT PRACTICE QUESTIONNAIRE**

### **Identifying material**

#### **Part A: Establishing requirements and changes to them**

- A1 User consultation*
- A2 Data providers' interests*
- A3 Authority for production*

#### **Part B: Designing and implementing the process and changes to it**

- B1 Concepts and definitions*
- B2 Methodology*
- B3 Completeness and fitness for purpose*
- B4 Key assumptions*
- B5 Risk assessment and contingency planning*
- B6 Implementation*

#### **Part C: Operating the system**

- C1 Training and instructions*
- C2 Incoming data quality*
- C3 Response (where applicable)*
- C4 Outgoing data quality*
- C5 Accuracy*
- C6 Confidentiality*

#### **Part D: Disseminating the results**

- D1 Availability of the statistics*
- D2 Pre-release arrangements*
- D3 Metadata*
- D4 Comparability and revisions*

#### **Part E: Re-establishing requirements... (links back to Part A)**

- E1 User satisfaction*
- E2 Review*

## **PROCESS QUALITY MEASURES FOR SOCIAL SURVEYS**

For household surveys ONS has been developing proposals for a number of different indicators of the quality of the survey processes. (Haselden and White, 2001). These have been developed following detailed work to identify key processes and the outputs of each process. This process map has then been used to identify and develop appropriate indicators of the quality of each process. Some, like response rates, are quantitative measures but many are qualitative descriptions of the processes undertaken which are likely to have an impact on quality. Some of these indicators will be for use mainly within the organisation to

monitor efficiency and effectiveness of its survey operations but most will be available to users so that they are in a position to judge the quality of the survey data and its suitability for their intended use.

The key survey processes and examples of the proposed quality measures are:

1. sample design and implementation - design factors, effective sample size;
2. questionnaire development, evaluation and programming - item don't know and refusal rates;
3. fieldwork preparation - experience of interviewers;
4. fieldwork training;
5. pre-fieldwork data transmission;
6. fieldwork - response rates, interview lengths, calls patterns;
7. post fieldwork data transfer - loss of data;
8. data processing;
9. analysis and report writing;
10. overall.

Although these indicators has been developed in the context of household surveys it will be used as a model for developing similar process quality indicators for other types of surveys. Another task will be to consider these process quality indicators in respect to the ESS data quality attributes to identify where process quality indicators can be used in place of or to supplement direct data quality measurements.

## **GSS<sup>5</sup> STATISTICAL QUALITY CHECKLIST**

Having recognised that users of statistics need information which enables them to assess the quality of the data the UK has developed a set of guidelines on providing this information. The guidelines, which were published in 1997, provide producers of statistics with a checklist of questions which should be considered when describing the statistics in a report or publication. Although drafted mainly in the context of survey data, many of the questions relate equally to data from administrative sources. In addition to the checklist of questions, the guidelines also provide examples of information on quality taken from existing UK statistical outputs. This Checklist will be reviewed as part of the programme to ensure that it covers the full range of data quality attributes, illustrative examples are up to date and it reflects the increase in electronic dissemination of statistics.

## **VARIANCE ESTIMATION**

One area where considerable effort has already been put is the development of variance estimation methods. In the context of sample surveys, sampling error is often considered as a key quality measure. Within the ONS several research projects have been set up in order to enhance variance estimation capability. Some of the technical issues faced when estimating sampling errors for business surveys are described in Davies(1999). The projects undertaken relating to business surveys include variance estimation methods for movements in business surveys, measuring the impact on variance due to survey methods and developing variance estimation for complex statistics. An outline of some of these projects and the challenges faced in developing suitable methods follows.

### Variance estimation for movements in business surveys

Currently sampling errors are only routinely available for estimates of levels although for many outputs it is the change that is the statistic of interest to users. The challenge is to estimate the covariance of the estimates between periods in the presence of dynamic populations due to birth, deaths and reclassifications and the use of rotating samples. Further details of this project are given in (Full and Lewis 2001).

### Measuring the impact of survey methods on sampling errors estimates

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The survey methods used within sample surveys have an impact on the estimates of variance, for instance the current method of outlier detection in business surveys is designed to introduce bias and reduce variance. Another example is the treatment of non-responders, in the business surveys imputation is used for unit non-response. Imputed values are then treated as actual values in both point and variance estimation, depending on the imputation method used this can lead to an underestimate of the sampling error and no estimate is made for the variance due to non-response. Some research has been carried out (Full 1999) using jackknife variance estimation and this research has shown that with the current imputation methods used sampling error is underestimated when imputed values are used as actual values. The jackknife method was not found to be suitable in the presence of high sampling fractions and the current imputation methods used are not easily incorporated into the Taylor linearisation methods.

### Variance estimation for complex statistics

Another challenge in variance estimation is to develop methods which are suitable for more complex statistics. One example is the Index of Production (IoP) which is a key economic indicator. This index is constructed from estimates from several ONS business surveys along with estimates obtained from non-ONS sources. Consultation with key users of the Index has indicated that it is the change in the IoP rather than the level that is of most interest. The challenge for this statistic is to be able to obtain all the necessary variances and covariances and then to develop a suitable method to estimate the sampling error of the index. This problem has been approached using a parametric bootstrap method to obtain the sampling error for the index. The development of this method is described in Full and Lewis (2001b).

Another project where ONS has recently developed estimates of variance of change relates to the Average Earnings Index. This index is accumulated as a succession of monthly movements of average earnings, each monthly movement being estimated on a matched pairs basis using the following formula  $I_t/I_{t-1} = w_{t,t-1}/w_{t-1,t}$  where  $I_t, I_{t-1}$  are the values of the index for months  $t$  and  $t-1$ , and  $w_{t,t-1}, w_{t-1,t}$  are the values of the average wage for months  $t$  and  $t-1$ , using data only for those employers which have supplied data for both months  $t$  and  $t-1$ . A fuller description of the Average Earnings Index is given in Chambers et al (2000).

Standard errors of these monthly movements have been available since a new structure of the index was implemented in 1999. However, users' main interest is in the year-on-year movements of the index because bonuses and other seasonal influences generate additional variability in the monthly movements. The year-on-year movement can be expressed as:  $I_t/I_{t-12} = \prod_{r=0}^{11} w_{t-r,t-r-1}/w_{t-r-1,t-r}$ . Clearly, estimating the standard error of this complex statistic is not straightforward. The project has taken two approaches to estimating standard errors of year-on-year movements: Taylor linearisation and jackknife.

The Taylor linearisation approach requires the estimation of variance-covariance matrices for the  $\{w_{t-r,t-r-1}, w_{t-r-1,t-r}\}$ . The detailed structure of these average wages is as follows:

$$w_{t,t-1} = \sum_{i,k} \theta_{ik} \frac{\sum_j \gamma_{ijkt} W_{ijkt}}{\sum_j \gamma_{ijkt} E_{ijkt}}$$

$$w_{t-1,t} = \sum_{i,k} \theta_{ik} \frac{\sum_j \gamma_{ijkt} \left( \frac{E_{ijkt}}{E_{ijkt-1}} \right) W_{ijkt-1}}{\sum_j \gamma_{ijkt} E_{ijkt}}$$

where:  $E_{ijkt}$  and  $W_{ijkt}$  are the total number of employees and total wage bill in month  $t$  for NACE division  $i$ , size band  $j$  and sector (Public or Private)  $k$ ;  $\gamma_{ijkt}$  is the grossing factor for NACE division  $i$ , size band  $j$  and sector  $k$ ; and  $\theta_{ijkt}$  is the fixed industry weight for NACE division  $i$ , sector  $k$ .

The estimation of variance-covariance matrices for the  $\{w_{t-r,t-r-1}, w_{t-r-1,t-r}\}$  depends, ultimately, on estimating the variances and covariances of the stratum level random variables  $E_{ijk_r}$  and  $W_{ijks}$  for months  $r$  and  $s$ , respectively. However, we have found that estimates of  $Cov(X_{ijk_r}, Y_{ijks})$  (for  $X = E$  or  $W$ ,  $Y = E$  or  $W$ ) based on the common sample for months  $r$  and  $s$  are not necessarily consistent with estimates of  $Var(X_{ijk_r})$  and  $Var(Y_{ijks})$  because of the reduced data set used to estimate  $Cov(X_{ijk_r}, Y_{ijks})$ . We have resolved this problem by using the estimator

$$Cov(X_{ijk_r}, Y_{ijks}) = \rho \sqrt{[Var(X_{ijk_r}) \cdot Var(Y_{ijks})]} ,$$

where  $\rho$  is the correlation coefficient between  $X_{ijk_r}$  and  $Y_{ijks}$ , estimated from the common sample for months  $r$  and  $s$ . This estimator ensures consistency between estimated covariances and variances.

A further problem regarding mutual inconsistency amongst covariances arises from consideration of partial correlation coefficients. We have found, however, that the required relationships for the partial correlations are not always met in practice, because of inconsistencies in the disparate data sets used to estimate the correlation coefficients. We have made some pragmatic adjustments to remove the more obvious inconsistencies but some less obvious ones clearly remain, because a few of the indices by industry sometimes generate negative variances for year-on-year movements. These problems may be caused by inconsistencies related to higher order partial correlation coefficients. Much work remains to be done in this area.

The jackknife approach does not suffer from the inconsistency problems which arise with Taylor linearisation but there is considerable uncertainty as to how best to correct for finite populations, an important consideration in business surveys. This is particularly problematic for the Average Earnings Index because populations and samples change over time with regard to both size and constituent units. Again, ONS has taken a pragmatic approach to the application of finite population correction factors but a deeper theoretical analysis is required.

Reassuringly, the Taylor linearisation and jackknife methods produced similar estimates of standard errors of year-on-year movements. Although these estimates are imperfect, ONS is sufficiently confident in their reliability that it intends to publish soon the results to date, in summary form. ONS also intends to use these standard errors to determine which industry index series to publish and to provide an indicator of quality to users.

## **EUROSTAT FUNDED RESEARCH**

The ONS led a Eurostat funded research project on Model Quality Reports in Business Statistics to develop guidelines for producing quality reports for business survey outputs. (ONS, 1999a,1999b,1999c,1999d). The study included a review of the theory and methods for quality assessment and a comparison of software for variance estimation, in terms of suitability for business surveys and comparison of performance. As part of this model quality assessment reports were prepared for both a structural and short-term surveys in the UK and Sweden. The experiences in preparing these model quality reports were then used in drawing up the recommendations and guidelines for the production of quality assessment reports. The study concluded that quality reports should be organised into three sections; a summary of quality assessments; the more detailed quality report and a description of the survey and its processes. Other recommendations that were made included that both survey managers and methodologists should be involved in the quality assessment work, that the tools for quality assessment need to be available and shared so that users of different surveys are presented with a similar approach to quality assessment. The study also noted that the availability of data is critical and recommended that careful planning is used to



ensure that datasets are available when needed. It was also recommended that quality assessment should be part of the results process to ensure that maximum use is made of the information on quality. Although this work was confined to business surveys the lessons learnt will now be used to develop quality reporting for all types of ONS outputs.

## 5. CONCLUSIONS

The development of a comprehensive system of quality measurement and reporting is a challenging undertaking. The desired outcome of this programme will be that users have access to a full range of quality measures and indicators so that they are able to understand the strengths and limitations of official statistics and to use them appropriately. The availability of comprehensive quality measures will also be used to within ONS to monitor improvement and to provide support to implementing changes to achieve continuous improvement.

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