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How Do We Reduce Non-sampling Errors?

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1. Introduction

It is now agreed that non-sampling errors are often more significant than sampling errors, particularly for large collections. Until recently, far more research and resources have been devoted to developing sample designs and estimation methods than methods that reduce non-sampling errors. This is also true of papers published in statistical journals.

It is gratifying to see a change taking place. Today much of the material presented at conferences of survey statisticians is devoted to non-sampling errors. Many statistical offices, including the Australian Bureau of Statistics (ABS), are also devoting relatively more resources to analysing and measuring sampling errors. Keane (1986) describes the plans of the U.S. Bureau of the Census which has always been a leader of developments in non-sampling errors.

In this essay, I hope to achieve three objectives. First I will describe some studies in Australia which have attempted to measure the relative importance of sampling and non-sampling errors. Second, by describing some non-sampling error studies I hope to demonstrate their value. Finally I have outlined some new technological developments that might help to reduce non-sampling errors.

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2. The Importance of Non-sampling Errors

We have undertaken studies of the impact of sampling and non-sampling errors on the monthly unemployment and employment series. These studies are more fully discussed in Steel and de Mel (1987) and Trewin (1987).

Apart from seasonal factors, there are at least three other explanations of fluctuations from the trend.

(i) sampling errors,

(ii) non-sampling errors, and

(iii) irregular factors which would exist even if perfect measurement methods were available. These are often referred to as socio-economic shocks.

The monthly unemployment series is shown in Fig. 1. The series has been derived from the labour force survey which is a monthly household survey. Respondents are enumerated by a personal interview of any responsible adult resident in the household; that is, proxy interviews are obtained for many household members. The monthly labour force survey is usually accompanied by a supplementary survey on a variety of labour force or social topics. The standard error of month to month movements at the national level is about 1.1% of the level of unemployment.

Many of the deviations from the underlying trend are far greater than the standard error. The pattern is not explainable solely by sampling error and other factors appear to contri-

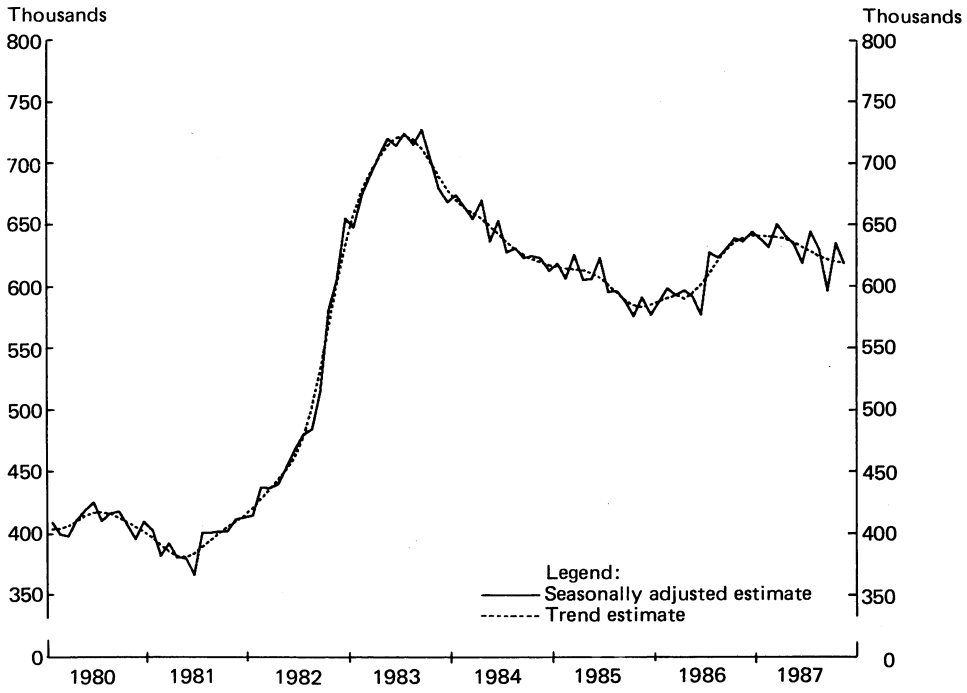

Fig. 1. Unemployed persons – seasonally adjusted and trend estimates

bute to the volatility of the series. Non-sampling errors might be the cause of this volatility and there is evidence that supplementary surveys contribute to the size of non-sampling errors in some months.

Steel and de Mel (1987) have developed a methodology to estimate the irregular component of seasonally adjusted series that is due to sampling error. The results are shown in Tables 1 and 2.

Table 1. Estimates of the percentage of the variance of the estimated irregular component attributable to sampling error – unemployed persons

State	Males	Females	Persons
New South Wales	50	49	34
Victoria	53	47	43
Queensland	87	77	73
South Australia	80	76	72
Western Australia	77	70	65
Tasmania	58	75	43
Australia	49	37	30

Table 2. Estimates of the percentage of the variance of the estimated irregular component attributable to sampling error – employed persons

State	Males	Females	Persons
New South Wales	89	76	69
Victoria	79	68	59
Queensland	77	71	58
South Australia	86	71	56
Western Australia	n.a.	66	77
Tasmania	n.a.	n.a.	84
Australia	63	67	44

n.a. not available.

For key aggregates at the national level, and for unemployed persons in particular, non-sampling errors may be more important than sampling errors. This confirms my earlier statement that relatively more resources should be devoted to limiting non-sampling errors. For disaggregated estimates, sampling errors are higher in relative terms, but the relative size of non-sampling errors tends to be the same so the percentage contribution of non-sampling errors is not as great.

3. Types of Non-sampling Error Studies

The importance of evaluation studies is often under-estimated. Evaluation studies provide information on the efficiency of the collection methodology, not only for the collection in question, but for other collections as well. They can also identify more efficient and accurate collection methods and provide valuable information about the quality of the estimates.

We now have a program of evaluation studies for each of our major economic industry collections. The 1984/85 Construction Industry Survey (CIS) was an early example of this program. Some of the key results of this program are described below.

(a) The CIS is a sample survey selected from all construction businesses. A range of structural financial and activity data is collected. Field enumeration was used for the sample of small construction businesses. However, mail enumeration was used on a test sample followed by a post-enumeration survey. The investigation showed that we should abolish the field phase and use mail methods because of reduced costs and accuracy if the mail forms are easily understood and are despatched after taxation returns have been completed.

(b) The evaluation studies included a unit record reconciliation between the Construction Industry Survey (annual data) and data from quarterly surveys of capital expenditure, stocks, and employment. The businesses were queried for explanations of large differences. A number of causes were found such as: punching errors, non-standard accounting years, inconsistent interpretation of statistical units, and misinterpretation of data item concepts. Conceptual inconsistencies at least, can be reduced by improved form design. We are also embarking on a program to improve the recording of the structure of large businesses on the business register, to reduce problems with misinterpreted units.

(c) A number of sources were used to improve coverage for the construction sector. Studies showed that these supplementary sources were of limited benefit except for income tax sources and, in the

future, we will rely on income tax as the only supplementary data source. This will reduce the costs of developing the survey frame work.

There were several other non-sampling error studies undertaken but I trust that these three examples illustrate the value of such studies. Yet evaluation studies are not often included in survey plans. Even when included, they can be the first target of budget cuts, which is short-sighted. Methodologists should argue forcibly for the inclusion or retention of evaluation studies. Methodologists also have a responsibility for developing the methodology for such studies, helping with the analysis and conclusions, and developing recommendations from the conclusions.

Survey statisticians can learn a lot from exchanging experiences and I would like to encourage survey researchers to publish their results more frequently. I found the description of evaluation studies conducted in conjunction with the 1977 and 1982 United States Economic Censuses (Monsour (1985) and Wolter and Monsour (1986)) to be most useful for developing similar studies in Australia. Wolter and Monsour (1986) also provide many valuable reasons for undertaking evaluation studies.

4. Technology's Role in the Reduction of Non-sampling Errors

Over the last 20 years, computers have been used extensively for editing and non-response imputation. Methods have improved significantly over this period and Fellegi and Holt (1976) provided an underlying framework for many editing systems.

Recent technologies, particularly microcomputers and distributed systems, provide further opportunities to improve data quality, including lessening the impact of non-sampling errors. I would like to briefly mention four activities which are currently under development or investigation at the ABS.

1. CATI and CAPI systems have a great potential to improve data quality. They provide an instrument that allows for greater control than the normal paper questionnaire. There is less leeway for interviewers to make errors. Also, the integration of data collection, data entry, and editing reduces the chance of errors in these processes. Immediate feedback of possible errors allows interviewers to query during the interview which surely results in a more efficient editing process.

   There are other important quality control processes which can be built into CATI systems. For example, supervisors can monitor interviewer performance, interviewer-respondent interaction, and questionnaire performance without the interviewer knowing any monitoring is taking place. Not only do such processes keep interviewers "on their toes," but they provide a more accurate measure of interviewer and questionnaire performance and provide better data on which to base corrective measures.

2. Computer-assisted coding systems and automated coding systems offer the potential for more accurate and less expensive coding systems. It is generally recognised that such coding systems result in more consistent coding. Statistics Sweden used automated coding in its 1980 census and the error rate from the coding process was reduced significantly. The ABS used computer-assisted occupation coding for the processing of its 1986 population census. Although no hard data are available, it is confidently expected that both the error rate and the between coder variability were reduced.

3. Computer-assisted editing and imputation systems such as those described by Denteneer et al. (1987) have the potential to reduce error rates as well as decreasing the cost of the edit and imputation processes. Bethle-

hem (1987) describes some experiences of the Netherlands Bureau of Statistics and concludes that computer-assisted interactive edit and imputation systems are more cost effective than the traditional batch editing processes. Their BLAISE system is worth consideration by all statistical offices.

4. Graphics, particularly if used interactively, may enable both input and output editing to be undertaken more quickly and efficiently. Outliers, which have a real impact on estimates, can be identified readily and with less data manipulation than is the case with normal batch editing process. The use of brushing (described in Cleveland and McGill (1987)) can also enable the subject matter analyst to study the impact of data amendments on different combinations of variables. There is a tendency to over-edit our data (several ABS studies have shown much editing to be ineffective) and graphics enable us to quickly turn our attention to the most important outliers.

5. References

Bethlehem, J.G. (1987): The Data Editing Research Project of the Netherlands Central Bureau of Statistics. Proceedings of the Third Annual Research Conference, Bureau of the Census, U.S. Department of Commerce, Washington D.C.

Cleveland, W.S. and McGill, M. (Ed.) (1987): Dynamic Graphics for Statistics. Wadsworth, Belmont, CA.

Denteneer, D., Bethlehem, J.G., Hundepool, A.J., and Keller, W.J. (1987): The BLAISE System for Computer-Assisted Survey Processing. Proceedings of the Third Annual Research Conference, Bureau of the Census, U.S. Department of Commerce, Washington D.C.

Fellegi, I.P. and Holt, D. (1976): A Systematic Approach to Automatic Edit and Imputation. Journal of the American Statistical Association, 71, pp. 17–35.

Keane, J.G. (1986): Have We Erred in Nonsampling Error. Proceedings of the Second Annual Research Conference, Bureau of the Census, U.S. Department of Commerce, Washington D.C.

Monsour, N.J. (Ed.) (1985): Evaluation of the 1987 Economic Censuses of the United States. Journal of Official Statistics, 1, pp. 331–350.

Steel, D.G. and de Mel, R. (1987): The Contribution of Sampling Error to the Variability of Statistical Series. Unpublished paper available from the Australian Bureau of Statistics, Belconnen.

Trewin, D.J. (1987): Estimation of Trends and Time Series Models from Continuing Surveys. To be published in the Bulletin of the International Statistical Institute.

Wolter, K. and Monsour, N. (1986): Conclusions from Economic Censuses Evaluation Studies. Proceedings of the Second Annual Research Conference, Bureau of the Census, U.S. Department of Commerce, Washington D.C.

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