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Statistical Methods at the Netherlands Central Bureau of Statistics

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Abstract: An overview is given of research work at the Department for Statistical Methods of the Netherlands Central Bureau of Statistics. This overview is set against the background of the organization of the Netherlands Central Bureau of Statistics.

1. Introduction

As with every large data producing institution, statistical methods play an important role within the Netherlands Central Bureau of Statistics (CBS). This note aims to give an impression of the work at CBS in the field of statistical methods, and more specifically the work of the Department for Statistical Methods.

To set the stage, Section 2 gives a brief outline of the function and organization of CBS. Section 3 introduces the Department for Statistical Methods, and Section 4 discusses some focal themes of research. Section 5 contains the conclusion.

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2. Function and organization of the Netherlands Central Bureau of Statistics

2.1. Function of the Netherlands Central Bureau of Statistics

The Netherlands Central Bureau of Statistics, instituted by royal decree in 1899, is the central agency in the Netherlands charged with producing statistical information on behalf of the central government. Although as such it is a part of central government, as a public agency its output is aimed at society at large and is not primarily intended for government use only. Unlike the situation in various other countries, almost all major statistical work for general use done at the central government level is concentrated in this single agency. Thus there are no separate agencies for such different tasks as national accounts compilation or the production of labor statistics. At the same time, the CBS is not involved in planning or prediction work.

Administratively and budgetarily, the CBS is part of the Ministry of Economic Affairs. For guidance on content and subject matter

of the statistical program, however, CBS looks to the Central Commission for Statistics (CCS) rather than to the Minister of Economic Affairs. The CCS, which has about 50 members, represents a variety of groups in Dutch society, such as the labor unions, employers' organizations, universities, and the various ministries. This structure gives CBS the appropriate independence from any direct political or administrative influence on the contents and methods of the statistical information it publishes, or on the form or timing of that information.

2.2. *Organization of the Netherlands Central Bureau of Statistics*

Under the overall management of the Director General of Statistics, CBS consists of four directorates, also called branches. These are:

- directorate for Statistical Methods and Development (including the Computer Department): the M-branch;
- directorate for Economic Statistics: the E-branch;
- directorate for Social Statistics: the S-branch;
- directorate for Administrative Management (personnel, finance, printing, etc.): the A-branch.

Each branch consists of a number of departments (29 in all), which are the basic organizational units within CBS. The total workforce of CBS amounts to over 3 000. A main difference between the E- and S-branches is that in the E-branch *firms* are the primary basic units of interest and in the S-branch it is *individuals* or *households*. This means, by and large, that data collection in the E-branch is often based on integral counts of populations (usually business sectors), whereas the S-branch frequently uses sample surveys of individuals. As a result the demand for statistical methodology in the area of surveys tends to be larger from the S-branch than from the E-branch. In practice, it must be added, this distinction between the E- and S-branch is not always sharp; for example, demographic statistics are based on population data, and a number of economic statistics use sample surveys, if only to cover the smaller firms. Moreover, the E-branch deals with all kinds of data that are not linked to firms, like those on prices and foreign trade, whereas the S-branch deals with wages and a number of firm-like entities such as schools, churches and law courts.

For the discussion later, it is of interest to note that most 'subject-matter' departments in the E- and S-branch contain (usually small) study groups to perform methodological work that is specifically of interest to that department.

As a result of past government policy on regional employment, the CBS is split up into two separate locations. One part of the CBS is in Voorburg, a suburb of The Hague, the other in Heerlen, about 200 kilometres from Voorburg in the southernmost part of the country. In addition, there is a relatively small unit mainly for data entry in Apeldoorn the middle of the country.

3. The Department for Statistical Methods

Most of the work on statistical methods takes place within the Department for Statistical Methods, a department within the Directorate for Statistical Methods and Development. Before turning to its actual work, we will briefly deal with the department in general.

The main task of the department, which in an early form was started by the well-known econometrician Jan Tinbergen in the late thirties, is to do research and give advice about statistical methods in the widest sense, as required by developments in the CBS. As such it serves as a research and development center of CBS, aiming at improving the quality of the statistical information produced by CBS. Its work is disseminated by giving advice

to the subject-matter departments, by occasional participation in developing new statistical projects or by solving particular problems of statistical analysis, by distributing papers, and by presenting lectures and courses. Occasionally, when required, advice is also given to institutions outside CBS, mainly on sampling problems and seasonal adjustment of time series. The department does not bear direct responsibility for any data produced by CBS; this responsibility lies with the subject-matter departments.

The department's work is centered around five focal areas:

1. Sampling;
2. Econometrics;
3. Sociometrics;
4. Applied mathematics;
5. Statistical computation.

In all these areas, research is done both to cater to the needs of the subject-matter departments and , at a more general level, to develop and implement new methods of actual or potential use of CBS. The department concentrates on those methods that are useful to more than one department: as pointed out before, problems specific to a single department (e.g., those on price index numbers) are usually dealt with by study groups at that department. Most of the advisory work of the department is in survey sampling; the department is usually involved in all stages of any survey conducted at CBS.

The staff of the department consists of about 30 people, including administrative and computer support staff. The staff members have different academic backgrounds. In addition to mathematicians there are economists, sociologists, psychologists and engineers. As a rule, their work is not limited to one focal area but shifts between areas over time. Projects in each of the five areas are supervised by a senior staff member; a sixth senior staff member is in charge of a small group in Heerlen, the larger part of the staff being concentrated in Voorburg.

4. Research projects at the Department for Statistical Methods

4.1. Introduction

In this section we discuss some key research topics for each of the five areas mentioned before. The references provided are all written in English and can be obtained by writing to the department. A more comprehensive list of papers, including papers in Dutch, can be found in (CBS (1982,1983,1984,1985)), which also contains abstract in English of all papers.

4.2. Sampling

A major research effort in the field of sampling is directed to the analysis of *nonresponse* (Bethlehem (1981), Bethlehem and Kersten (1981a, 1981b, 1982), Kersten (1984)). Nonresponse is an increasingly important phenomenon in the Netherlands, as elsewhere, and operational methods to analyze its incidence and impact become accordingly valuable. As a result of this research, which consists both of the implementation of existing methods and the development of new ones, a nonresponse analysis is now frequently performed when a household survey has been carried out. This analysis is used to determine whether a survey should be extended over additional households, and serves as a base for post-stratification and weighting. In this context, the *basic question method* (see Kersten and Bethlehem (1984)) developed at CBS, should be mentioned: in an oral survey the interviewer tries to elicit, from somebody who appears not to want to participate, the answer to a certain question on the questionnaire that is related to the main theme of the survey and which can be used for post-stratification. Also new methods have been developed based on linear and log-linear models for *weighting* a sample in case of empty cells or access to partial auxiliary information about the population. (See Bethlehem and Keller (1982, 1983a, 1983b), Bethlehem (1984), Pannekoek (1984).) Much

attention is paid also to other *nonsampling errors* which have an important impact on the quality of survey results. This work concerns frame errors, coverage errors, interview effects and response errors.

Various special *sampling schemes* are presently being developed, such as multidimensional sampling (sampling in space and time), methods to spread the response burden over different firms and individuals, and methods for adapting fixed samples to changes in the population (see de Ree (1983), Bethlehem and Schuerhoff (1984)). Another important study concerns the impact on the quality of statistics of the use of various sampling frames, such as the Post Office dwellings register vis-à-vis the municipal population registration. (See de Ree and Nieuwenbroek (1981).)

4.3. *Econometrics*

Econometric research comprises both theoretical and empirical research. Topics of *theoretical* research include regression analysis with errors in the variables (see Kapteyn and Wansbeek (1983, 1984), Bekker et al. (1984), Wansbeek et al. (1984a, 1984b)), regression with categorical data (see Keller and Wansbeek (1983)), regression on data from sample surveys (ten Cate (1983)), specification analysis (Rijken van Olst (1982)), regression analysis of longitudinal data, and other research (see Neudecker and Wansbeek (1983), Kapteyn and Wansbeek (1982a, 1982b), Wansbeek and Kapteyn (1983), Wansbeek (1984), Verbeek (1984)).

The *empirical* work covers a variety of subjects. The CBS disposes of a large amount of micro-data on individuals and firms, and for reasons of confidentiality most of these data cannot be made available to researchers outside CBS, in particular those on firms. This is one of the reasons for which the CBS, and the Department for Statistical Methods in particular, is involved in econometric analysis of micro-data; another reason is the expectation that feedback of data analysis will improve the data collection process.

One topic of research has been an analysis of *investment* in Dutch manufacturing (see ten Cate (1980,1984)). This project consists of estimating an investment function at the micro-level using data on all firms over the 1972–1977 period. This analysis is currently being extended to incorporate the effects of capital. As capital is not measured, latent variable methods will be used. This same data set has been used to analyze the intertemporal developments of *firm size* by means of Markov processes. The expectations and realizations in the CBS-business test are also being analyzed by means of the loglinear probability model (Ekker (1983)) and disequilibrium analysis (Kooiman (1984)).

In the field of consumer behaviour, research topics include the estimation of price and income *elasticities* of consumer durables, family equivalence scales (Keller (1983)), the evaluation of incomes (see Wansbeek and Kapteyn (1981, 1982), Kapteyn and Wansbeek (1982c)), and various topics in the field of consumer demand models (see Sikkel (1982a), van Driel (1982a, 1982b), Kapteyn et al. (1983)). Among these latter is the development and testing of a new class of models that are akin to the well-known AIDS and Rotterdam models, but have certain advantages when it comes to estimation, especially in the presence of highly disaggregate data like those available at CBS (see Keller and van Driel (1982), and Keller (1984)).

A pilot research project has recently been completed dealing with the construction of statistics on *real income changes* of households in the Netherlands. Two different figures are computed, the dynamic and the static figure. The dynamic figure reflects the change in real income as experienced by individuals, and is based on longitudinal data: two panels resulting from an exact match between three files

from the Netherlands IRS. The static figure reflects the change in real income of positions (e.g., of a 60-year-old civil servant) instead of individuals. It is based on micro-simulation: we simulated changes in wages, taxes, etc. on a sample of individuals for which socio-economic and demographic positions were assumed constant (see Keller et al. (1985)).

4.4. *Sociometrics*

Just as with econometrics, the heading 'sociometrics' covers both theoretical and empirical research. The theoretical work lies mainly in the field of multivariate analysis, with special attention to variables of an ordinal or nominal measurement level. Contributions have been in the fields of *correspondence analysis* (Sikkel (1979, 1980a, 1981), Israëls and Sikkel (1982, 1983)) and extensions thereof (Israëls (1983, 1984a)) and *loglinear models* (Pannekoek (1980, 1983), Pannekoek and Stronkhorst (1981)), both as a method of estimating relations between variables and as a tool for reducing large tables to smaller ones. Both methods are now regularly used at CBS to present survey results in a condensed fashion. In general, there is a strong emphasis on exploratory analysis of large data sets. (See Sikkel (1980b), Israëls and van Driel (1983), Jansen (1980, 1982), van Driel and Israëls (1981), ten Cate (1982), Kapteyn et al. (1982), Israëls (1984b), Pannekoek (1982a, 1982b), Stronkhorst and Pannekoek (1983).) Recently a simple but powerful technique for the analysis of qualitative data (tables) has been developed, analogous to least-squares for quantitative data (Keller and Verbeek (1984)). With this technique it is possible to analyze relationships between a large number of variables simultaneously.

An interesting experiment has been the 'mystery file' project. Seven staff members were given a four-dimensional categorical data set of unknown content, and each of them was invited to apply his or her favorite method to detect structures in this set. The methods were simple visual inspection plus rearranging, ridit analysis, stepwise selection using a chi-square statistic, loglinear analysis, cluster analysis and principal coordinates analysis, correspondence analysis, and regression analysis. This project was highly instructive in assessing the relative merits of the methods. (See Bethlehem et al. (1981.))

Various methodological problems in survey research are of continuing concern. Often pilot studies are used to gain experience with gathering information for new subject matter. Then research is done in cooperation with the department concerned, to select for example the overall design of a survey, the optimal method for data collection, the wording of questions, or items that can be used for scaling. *Panel surveys* that allow observation of change on an individual level lead to research on (rotating) sampling schemes and models to describe these data. (See van de Pol (1982, 1983a, 1983b, 1984), van de Stadt et al. (1984).) Analysis is done to determine *recall and telescoping effects* in retrospective questions on medical consumption and victimizations (Sikkel (1984)) and renewal theory is used to develop stochastic Poisson-type models that describe events over time (Sikkel (1982b, 1983)). Furthermore, the effects are being evaluated of using answers from *proxy informants* as substitutes for the sampled persons in a survey. A promising experiment was recently done to evaluate the utility of hand-held microcomputers in the data collection for household surveys (see also Section 4.6).

4.5. *Applied mathematics*

Various other topics come under this heading. The most important ones are related to *statistical disclosure avoidance* and *time series analysis*.

An important aspect of the operation of any statistical agency is safeguarding the anonymity of data on individuals, be they firms or people. Since there is a growing demand for more detailed data, in particular for micro-data on tape, the problem of disclosure avoidance becomes increasingly acute, the more so in view of the increasing extent to which statistics in different areas are integrated and coordinated. There are two basic lines of research:

- In a rectangular table, totals or averages pertaining to too few units (five, say) are suppressed and replaced by 'x'. When marginal totals are given, this technique does not suffice and additional x's must be added in some optimal way. This problem becomes considerably more complicated when there are additional tables or other sources of information pertaining to the same units.
- When micro-data on tapes are supplied to researchers outside CBS, the data must be condensed to prevent identification of individuals. An optimum must be found between the risk of identification on the one hand and adequate data content on the other. This problem is also complicated by possible matching with data from other sources.

The department actively participates in a working group across the entire CBS that formulates rules and standards; it also develops methods and computer tools for disclosure avoidance and advises other departments in complex situations. The final responsibility for disclosure avoidance, however, remains with the subject-matter departments concerned.

In time series analysis, work centers around seasonal adjustment of time series (see van der Hoeven and Hundepool (1981)). A somewhat more flexible variant of the Census X 11 method has been developed and is used for seasonal adjustment of the various monthly unemployment series. This is often not a routine procedure; for example, a major redefinition took effect on January 1, 1983, which caused a one-time jump in the level of the series by some 15 percent. It took extensive research to account for this disruption properly. In addition, Box-Jenkins time series analysis methods are used to assess the effect of e.g. traffic legislation on traffic accidents and fatalities over time (see de Beer and van de Pol (1984)).

Research is also done on models for predicting fertility of demographic cohorts. A continuous project at CBS has been forecasting the size and composition of the Dutch population. In view of rapidly changing fertility behaviour over the last two decades, it has become increasingly difficult to estimate the future population accurately, and new methods have been required to take these changing patterns into account. The department has made significant contributions to this subject, e.g. by extending Box-Jenkins and Kalman filtering methods to suit this specific type of problem (see de Beer (1982 a, 1982 b, 1983 a, 1983 b)).

4.6. *Statistical computation*

Although the production of computer software traditionally has been the task of the computer department, the increasing connection between methods and software has created a task for the Department for Statistical Methods as well. The work includes both software development for methods developed at or introduced by the department, and the evaluation and possible extension of software developed elsewhere to suit the specific demands of CBS (see Verbeek and Bellm (1984)). Software is developed for correspondence analysis (Israëls and Sikkel (1983)), logit analysis (Keller and Verbeek (1984)), loglinear analysis (Denteneer and Verbeek (1983), Verbeek (1983), Pannekoek (1983), and Verbeek and Denteneer (1984)), estimation of memory effects (Sikkel (1983)), disclosure avoidance, and seasonal adjustment (van

der Hoeven and Hundepool (1980)), most software being available in both mainframe and microcomputer versions. A major effort has recently been started in collaboration with the computer department to develop software for the data-editing process in statistical production.

The department is also deeply involved in two experiments with hand-held computers for data collection in the field. Software is developed for a hand-held microcomputer (the NEC PC–8201A), for data collection in the Prices Survey and various household surveys. Two experiments were conducted to test whether it was feasible, without loss of quality, to conduct the fieldwork of both types of surveys with a hand-held computer. It turned out that for household surveys the answer is "yes", while for the Prices Survey some reservations had to be made with respect to the computer used (Bemelmans-Spork et al. (1984, 1985)).

5. Conclusion

This note has given a brief overview of research at the Department for Statistical Methods of CBS. This overview has been placed in the context of the organizational structure of CBS. We hope that it has not only provided dry information on the things we are doing, but has also given an impression of what we feel constitutes a richly varied research environment. On the one hand, the department bears no direct production responsibilites, and thus has ample scope for pursuing long-term research interests, but on the other hand the continuous needs of CBS are such that the risk of 'splendid isolation' is far away. We experience this as a stimulating duality.

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[2] These references are all available from the Department for Statistical Methods, CBS, The Netherlands. A reference given by author and title only indicates that it is an internal CBS memo.

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