POST '81 CENSAL REDESIGN OF THE CANADIAN LABOUR FORCE SURVEY

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1. Introduction

The Canadian Labour Force Survey (LFS), the largest monthly household survey conducted by Statistics Canada, has been redesigned in the past following each decennial census. As part of 1981 post censal redesign, an intensive program of research as outlined in an earlier paper (Singh and Drew 1981) was undertaken in the areas of sampling, estimation and data collection methodologies. This paper presents an overview of the findings of various theoretical and empirical investigations and field tests undertaken during the redesign program. Sections 2 and 3 provide the background information on objectives and the old design, while Sections 4, 5 and 6 highlight the findings of investigations leading to changes in sampling and data collection methodologies. Section 7 deals with estimation issues, and sample reallocations are discussed in Section 8. Implications of the changes made in the redesigned sample on other associated surveys are outlined in Section 9, and finally in Section 10 the benefits from the major improvements in the redesigned sample are briefly recounted, along with some mention of future plans.

2. Objective Setting

A fundamental step in the redesign of a recurring survey is the re-establishment of survey objectives. For the LFS, this involved reassessment not only of the survey's principal role as a provider of current labour market information, but also of its use as a central vehicle within Statistics Canada for conducting household surveys. At the early stages of the redesign program it was decided that while primary orientation towards the LFS should be maintained, efforts should also be made to enhance flexibility of the vehicle for general applications (Section 9).

Objectives relating to provision of labour market data were established in consultation with the statistical focal points within each of Canada's ten provinces, and with key federal user departments, through annual Federal/Provincial Conferences on Labour Statistics and bilateral follow-ups. In general, these consultations revealed satisfaction with data reliability for provincial and national data, but a strong desire for improved subprovincial data. Specific data reliability objectives adopted for the redesigned sample are as follows:

(i) for Canada and each of the ten provinces, no reduction in current reliabilities for monthly estimates of level and estimates of month-to-month change in total employment and unemployment.

(ii) for the 24 Census Metropolitan Areas as defined by the 1981 Census and for 66 subprovincial Economic Regions agreed to in consultation with the provinces, monthly estimates of unemployed with coefficients of variations (cv's) not exceeding 20% and 25% respectively.

Attainment of these objectives necessitated a reallocation of sample within the provinces from larger cities and Economic Regions to smaller ones. This, coupled with the desire to reduce the cost of the LFS, created a good deal of expectations from the research projects for identifying more cost efficient strategies for data collection and production of statistics from the LFS.

3. Old LFS Design

A complete description of the old LFS design is given by Platek and Singh (1976). Salient features are noted in this section to provide a context for discussions in later sections.

The Self-Representing Units (SRUs) in the old design corresponded to those cities which were sufficiently large to support at least one interviewer. Minimum SRU sizes ranged from a population of 10,000 in the Atlantic Region to 25,000 in Quebec and Ontario.

Within large SRUs, deep geographic stratification was carried out without any regard to optimality of characteristics. Primary sampling units, called clusters, corresponding approximately to city blocks, were delineated on the basis of field counts obtained in 1973. A two stage sample of clusters and dwellings was selected following the Rao, Hartley and Cochran (1962) pps random group method. In addition to the area frame, an open-ended list frame of apartments was maintained in the larger cities.

A major advantage of the selection method for the area frame lies in its flexibility for changes in the sample size. Also, since sampling is done independently in each random group, a Keyfitz (1951) sample update can be carried out, under which revised probabilities of selection based on recent dwelling counts can be incorporated, while maximizing retention of already selected units (Platek and Singh 1976, Drew, Choudhry and Gray 1978). Regular updating of high growth SR areas occured from 1978 until the beginning of the redesign period in 1982.

The Non-Self Representing (NSR) units are the areas outside the SRUs comprised of rural areas and smaller urban centers. In NSR areas, stratification based on industry classifications was carried out within Economic Regions, subject to the restriction that strata should be contiguous land areas. Within strata, Primary Sampling Units (PSUs) were delineated such that each PSU represented its stratum to the extent possible with respect to the ratio of rural to urban population and important LF characteristics. While the rural portions of a PSU were comprised of collections of contiguous rural EAs, urban portions could not always be made contiguous to the rural due to the restrictions placed on maintaining the rural to urban population ratio. Frequently larger urban centres had to be shared amongst several PSUs within the stratum.

At the time of the 1973 Redesign, two PSUs were selected per stratum using the randomized pps sys-

tematic method (Hartley, Rao 1962). In 1977, the LFS sample size was increased from 33,000 to 55,000 households monthly, with the additional sample being allocated so as to improve data reliability at the province level. Thus the smaller provinces received larger proportionate sample size increases. The increase was achieved in NSR areas by selecting 1-4 additional PSUs per stratum.

4. Redesign of the Self Representing Areas

For reasons noted earlier, the basic design in SR areas remained the same and the main thrust for these areas was to update the size measures without resorting to a costly independent field count as used in the last redesign.

In the built-up portions of larger cities, Census data can be retrieved at the blockface level. The adoption of Census blocks as clusters in these areas (with splitting or combining in only 5-10% of cases), permitted a highly automated design with very low redesign costs. Importantly as well, data for future Censuses will be available for geostatiscally stable blocks (but not for EAs which as operational units change at each Census), permitting low cost quinquennial updating of the sample. The built-up portions comprise 86% of these cities. In the non-built up portions the EA was adopted on the grounds that as a larger unit than the block it would be more robust to the highly concentrated growth which can occur.

In the smaller, non-blockfaced cities, Census blocks and EA's were also chosen as sampling units in the built-up and fringe portions respectively. Although dwelling counts for blocks had to be obtained manually from the visitation records and maps, this was nevertheless considerably less costly than obtaining independent counts as had been done in the last redesign.

The Variance study results, (Choudhry, Drew, Lee 1984) combined with cost results from the Time and Cost Study (Lemaître 1983), showed variances per unit cost to be quite flat in the range of 2-8 selected dwellings per cluster. Hence it was decided to keep the density of 4-5 dwellings per cluster used in the old design in strata where clusters were blocks, but to increase the density to 6-8 dwellings in the case of the EAs, due to their larger sizes.

5. Stratification

5.1 Algorithm and Choice of Stratification Variables)

A modified version of a non-hierarchical algorithm due to Friedman and Rubin (1967) was adopted for stratification purposes in both SR and NSR areas, on the strength of findings reported by Judkins and Singh (1981) (and Kostanich, Judkins, Singh and Schautz (1981))who evaluated several stratification algorithms for use in the U.S. Bureau of the Census' Current Population Survey. New features incorporated into the algorithm were a capacity to form geographically contiguous and/or compact strata, and the option to form either homogeneous clusters (i.e., strata) or heterogeneous clusters (i.e., primary sampling units within NSR strata). A detailed description of the method, and results of empirical evaluation studies are given by Foy, Bélanger, Drew and Joncas (1984).

For both NSR and SR areas, a multivariate stratification has been carried out using 1981 Census data for up to 17 stratification variables. Population variables include: total employed; employment income; persons with secondary education; population 15+, 15-24 and 55+; and labour force in agriculture, forestry-fishing, mining, manufacturing, construction, transport, and services. Dwelling related variables include: total dwellings, dwellings rented, one person households, and two person households. Unemployed was not included due to its instability. Study findings showed that strata formed without unemployed when evaluated at the next Census were more efficient not only for other characteristics, but for unemployed as well. The inclusion of the neighborhood type variables, on the other hand, did result in improved efficiency for unemployed.

5.2 Two Level Stratification in SR Areas

In the larger SRUs, two levels of stratification were adopted. Primary strata, with sample yields of 150-170 households from the area and apartment samples combined, are comprised of collections of geographically contiguous Census Tracts. As such, primary strata are designed to correspond to two interviewer assignments. Three to four non-geographic secondary areal strata are formed within primary strata. Apartments are sampled separately, from a list which generally comprises a single stratum for the entire SRU.

In the smaller blockfaced SRUs which warranted neither separate apartment sample nor geographic strata, optimal non-geographic areal strata were formed directly. In the non-blockfaced cities, with considerably less scope for stratification, simple geographic strata were opted for.

The two levels of stratification in the larger SRUs had appeal on both operational and technical grounds. The relaxing of geographic constraints over those existing in the old design permitted greater optimality to be achieved, while the retention of contiguity at a higher level will facilitate the planning of interviewer assignments. Also the non-geographic secondary strata should result in greater interpenetration of strata and interviewer assignments then existed in the old design, with the results that correlated response variance will be reflected in the estimated total variance.

Studies found first stage variance reductions for optimal versus single geographic strata to be 25% for income. Smaller gains in the order of 3-5% for characteristics such as unemployed and employed, however, point to the strength and robustness of the simple, but deep geographic stratification in the old design.

6. Design Considerations in NSR Areas

6.1 Extension of Telephone Interviewing

Background: Telephone interviewing for months 2-6 in the sample was introduced during the early seventies in SR Areas, primarily to reduce cost. However in NSR areas, all interviewing continued to be done in person due to concern over the high instance of party lines vis-à-vis the confidentiality of the data being collected. Nevertheless,

in recognition that not only immediate cost benefits from telephoning were at issue, but so also were the longer term potential benefits from the use of new technologies such as Random Digit Dialing and CATI, it was decided to test the feasibility of extending telephone interviewing to NSR areas.

A first field test was restricted to urban areas having over 80% private lines. The test was conducted on a portion of the actual LFS sample, with the principal objective of assessing the data quality implications of telephone interviewing. To facilitate this analysis, interviewer assignments were split between the telephone and personal procedure.

This test ran from January 1982 to June 1983 with a gradual phase-in to ensure no adverse impact on the ongoing survey. Principal findings were: lower non-response rates for the telephone sample (3.4% versus 4.3% for the control sample); a high instance of households with telephones (96% for all provinces but one); a low instance (1%) of households not agreeing to telephone interviewing; and no detectable differences in estimates for labour force characteristics.

A second test carried out in the rural areas had comparable findings. Based on the positive findings from both tests, the decision was taken to introduce telephone interviewing across the board in NSR areas during the remainder of 1983 and early 1984.

The decision to extend telephone interviewing had the following principal implications on the design of the NSR sample:

(i) Increase in assignment sizes: In the old design, NSR assignment sizes averaged 50 dwellings. Evidence that per unit costs were lower for larger assignments (Lemaître 1984), and the reduction in travelling under telephoning, both supported increasing the design yield per NSR PSU to 55-60 dwellings.

(ii) Level of assignment of rotation numbers: Unlike the old design, in the new design, all dwellings within secondaries will receive the same rotation number, which will cut down on visits to the secondaries in month 2-6 in the sample.

6.2 Elimination of Stage of Sampling in Rural Areas

In the old design, the rural sample within PSUs was selected in three stages: secondaries (Census Enumeration Areas), clusters, and dwellings. The clusters corresponded to identifiable land areas containing up to 20 dwellings, which were delineated on the basis of field counts obtained whenever a new secondary entered the sample. Within secondaries, generally 5-6 clusters, with 3-4 dwellings per cluster, were selected.

The rural cluster stage was identified early in the redesign program as a possible candidate for elimination, on the grounds that (i) the sampling variance would be reduced due to having one less stage of sampling, and (ii) the lead time required to introduce new secondaries into the sample could be shortened from 13 months to 7 months.

A field study was carried out on a sample of secondaries entering the LFS sample, in order to to assess the feasibility of maintaining good quality dwelling lists for entire rural EAs, and to examine costs under such a procedure, with positive results on both counts. The variance implications of eliminating the cluster stage were also studied. Using 1971 Census data to simulate both the old and alternative design, components of variance were obtained for the Horwitz-Thompson estimator without ratio estimation. The percent reduction in total variance under the alternative design was found to range from 20-25% for major labour force characteristics (Choudhry, Drew, Lee 1984).

On the basis of these findings, an early decision was taken to eliminate the rural cluster stage of sampling, and attention was turned to more global aspects of the NSR design.

6.3 Design with Urban/Rural Stratification

Two Alternate Designs: The old design featured implicit urban/rural stratification. PSUs were formed to have approximately the same ratio of urban to rural population as the stratum, and within selected PSUs the urban and rural portions were sampled independently. A premise underlying the design was that the PSU should correspond to an interviewer's assignment. However, in practice this correspondence was weakened since in order to attain the desired urban/rural ratio, frequently the urban and rural portions of PSUs were not contiguous.

As an alternative to old design, D_0, (with the rural cluster stage eliminated), a design D_1, featuring explicit urban/rural stratification was studied. Like D_0, the alternative design D_1 consisted of 3 stages of sampling in both urban and rural areas. In urban strata, the stages were: PSUs (consisting of individual or nearby urban centers), clusters, and dwellings. In rural strata, the stages were: PSUs, (consisting of collections of nearby rural EAs), secondaries (EAs), and dwellings. Under D_1, both urban PSUs and rural PSUs were designed independently to yield samples corresponding to interviewer assignments.

Cost Variance Study: The two design alternatives were evaluated, from the point of view of variance and cost (Choudhry, Drew, Lee 1984). In the variance study both designs were simulated for the case of 2 PSUs per stratum using design counts based on the 1971 Census, and study variables based on 1976 Census data.

In terms of costs, a simple model was developed for D_0, the old design under telephone interviewing), and components were estimated using results from a detailed Time and Cost Study (Lemaître 1983). Relative costs for the travel components between designs D_0 and D_1 were estimated by means of a simulation study, in which average dispersion of the sample under the two designs was obtained up to the second stage of sampling using the population centroids of the EAs.

Findings were that the design D_1 was 1.09 times as cost efficient as D_0, and that from the combined perspective of cost and variance, D_1 outperformed D_0 with overall efficiencies of 1.26 for

employed and 1.06 for unemployed.

Based on these findings, design D_1 was adopted in 70% of Economic Regions with sufficient urban and rural population to yield separate strata. In the remaining Economic Regions, with the exception of Prince Edward Island, design D_0 was adopted.

6.4 Number of PSUs Selected Per Stratum

In the LFS design, since the sample yield per PSU is fixed, the number of PSUs selected per stratum also determines the number of strata. In over two thirds of cases, the urban, rural or combined strata within ERs yielded only enough sample for 2 or 3 PSUs. Further stratification in these cases was ruled out on the grounds that there should be at least 2 PSUs per stratum to permit unbiased estimation of variance.

The remaining ERs were stratified to the point of 2 or 3 PSUs per stratum. Estimated first stage variance reductions over the situation under the old design of from 3-6 selected PSUs per stratum were up to 14% for employed (Choudhry, Drew, Lee 1984). The stratification was carried out using the clustering algorithm described in Section 5.

6.5 Use of Clustering Algorithm in Formation of NSR PSUs

In both the old and new LFS, stratification is carried out prior to formation of NSR Primary Sampling Units. PSUs are delineated within the stratum to be as similar as possible with respect to stratification variables, while being as geographically compact as possible. PSU delineation which was carried out using the clustering algorithm noted earlier, required minimization of geographic and maximization of the non-geographic variables.

6.6 Two Stage Design for Prince Edward Island

For Canada's smallest province, Prince Edward Island, sampling rates are 4% in order to produce monthly LF estimates with required levels of data reliability. In view of the high sampling rates, a less clustered design consisting of a two stage sample of EAs and dwellings, with deep geographic stratification was adopted. It was found to have marginally higher costs than D_0, however from the overall perspective of cost and variance, it came out well ahead with efficiencies of 2.21 and 1.11 for employed and unemployed relative to D_0 (Choudhry, Drew, Lee 1984).

7. Estimation

7.1 Final Stage Ratio Estimation

In the old LFS, a final stage ratio estimation was carried out by detailed province/age/sex cells. With the development within Statistics Canada of improved and more timely subprovincial population estimates, an intermediate ratio estimation step was studied in which survey estimates of population 15+ for subprovincial areas are ratio adjusted to external estimates, prior to the usual final ratio estimation. Findings were that the procedure, while not impacting on the variances of provincial level data, resulted in variance reductions for subprovincial areas ranging from close to 70% for employed to 7% for unemployed. In practice a raking ratio procedure in which the two ratio estimation steps are iterated until both marginal controls are satisfied was adopted, beginning in 1983.

7.2 Improved Estimates for Household and Family Units

Paul and Lawes (1983) used LFS longitudinal data files, which link households over the six months in the sample, to demonstrate that non-response rates are higher amongst households with fewer members. For the old LFS, non-response adjstment consisted of re-weighting at local area levels. This was done without regard to household size, hence the resulting estimates of households and families by size had 1-3% biases. Another problem related to the inconsistency of family and individual based statistics. When demographic estimates of families by size, currently under development by Statistics Canada's Demography Division, become available, it is intended to incorporate them as an extra dimension in the final stage raking ratio estimation procedure, to address both problems.

As an interim measure, LFS longitudinal data may be used to derive household size distributions based on both respondents and non-respondents, prior to the final raking ratio estimation.

7.3 Small Area Estimation

Demand for Labour Force estimates for small areas (domains) such as Federal Electoral Districts (FEDs) and Census Divisions (CDs), both of which number over 250 units across Canada, has increased in recent years. Since it was not possible to respect the boundaries of such areas in the design of the survey, various alternative small area estimation methodologies were evaluated. A sample dependent estimator was proposed as a combination of post-stratified and synthetic estimators, which relies entirely on the post-stratified whenever the sample size in the domain is sufficient according to certain criteria, and which otherwise introduces a synthetic component whose relative weight depends on the deficiency of the sample in the domain. Based on study findings, it was recommended that the sample dependent approach be developed as a means of providing annual or multi-year average estimates for areas such as FEDs and CDs (Drew, Singh, and Choudhry 1983). Implementation and further research and developmental work is proceeding under Statistics Canada's Small Area Data Program.

7.4 Variance Estimation

The methodology for variance estimation for the redesigned sample will continue to be based on Keyfitz's (1957) method, although it will be further modified to the case of a two step final stage ratio estimation, i.e., to a single iteration in the raking ratio estimation procedure. As subsequent iterations exert only a very small

influence on estimates, they are being ignored in variance estimation. Some further refinements of the current variance estimation procedure are under study, such as adopting clusters as replicates in SRUs, as opposed to the current practice of grouping clusters into two psuedo-replicates.

It should be noted that variance estimators given by Rao, Hartley, and Cohran (1962), and by Rao (1975) were evaluated as alternatives to the current method in SRUs, where the RHC design is followed. The current method was considered both with and without ratio estimation, while the alternatives were studied without ratio adjustment. The current method without ratio adjustment was found to overestimate the variance for certain characteristics (e.g., 20% for employed), however with ratio estimation, biases were negligible. Estimated biases were also negligible for the alternatives. The principal advantage of the alternatives was that they were more stable. The current method was retained however, due to its simplicity and also because of the complications in estimating variances of change or averages under the alternative methods.

7.5 Composite Estimation

In the LFS, moderate to high month-to-month correlations exist for most characteristics due to the 5/6'th common sample. Different composite estimators were studied by Kumar and Lee (1984), which take advantage of these correlations by use of data from previous samples to improve the current month's estimates. Their studies focussed on a class of AK composite estimators studied recently by Huang and Ernst (1981) and others in the context of the U.S. Bureau of the Census' Current Population Survey.

Findings under the assumption that the ratio estimator is unbiased, were that from the perspective of mean square error, a compromise choice of the A and K weights yielded up to 5% gains for monthly estimates of level for unemployed and employed, and from 5% - 16% gains for corresponding month-to-month change estimates. A decision on implementation of composite estimation was delayed pending further studies on the impact on composite estimators of any changes in rotation group bias, stemming from modifications in non-response adjustment and ratio estimation procedures, and pending closer examination of its operational implications.

7.6 New Rounding and Release Policy

In the old LFS estimates of level were rounded to thousands and released if greater than 4 thousand. This policy was applied uniformly in all provinces for all estimates, with the intent that released data should have a coefficient of variation of 33.3% or less.

More rigorous, provincially based rounding and release criteria were developed for the redesigned sample to satisfy the conditions that the CV of unrounded estimates should be 33.3% or less, and that the rounding error should not exceed 20% of the standard error of the unrounded estimate. Findings were that release criteria could be dropped to 2-3 thousand for all provinces except Quebec and Ontario, and that estimates for subprovincial areas should be rounded to hundreds instead of thousands.

8. Sample Reallocation

In addition to the general improvements in the data reliability levels resulting from the refinements in the methods and procedures, it became necessary to consider reallocation of the sample within provinces from larger CMA's and Economic Regions to smaller ones to meet the subprovincial data reliability objectives noted in Section 2. The reallocations also took into consideration study findings using the cost-variance model suggested by Fellegi, Platek and Gray (1967), which indicated that an optimal balance between NSR and SR sampling rates required a shift of sample from NSR to the SR areas.

For the 10 out of 66 Economic Regions and 6 out of 24 CMA's requiring sample size increases to meet the objectives, an average 24% reduction in the CV's for unemployed was achieved. In addition, for the 30 ERs with old CV's in the range of 15-25%, the reallocations achieved an average 7% reduction in CV's. As a rule of thunb, under the redesigned sample, monthly data for ERs and CMAs will be based on minimum monthly sample sizes of 300 households per month. It should be noted that in determining sample size requirements to meet the objectives, average unemployment rates for the period 1980-82 were used, in view of medium term forecasts for sustained high unemployment during the 80's.

While the reallocations to improve subprovincial data had an adverse impact on the provincial and national estimates due to the departure from the usual proportional allocations, this was more than compensated for by the structural improvements in the methods and procedures stemming from the research findings. The size of the redesigned sample was therefore fixed at 51,500 households per month down from 55,000. This overall reduction of 6-7% was achieved through a uniform reduction in all provinces with the exception of Prince Edward Island. In addition, per unit data collection costs will be reduced due to increased telephone interviewing.

9. Implications of Changes on LFS Associated Surveys

As noted earlier efforts were made in the redesign to enhance flexibility of the vehicle for general applications. In this light changes being adopted for the LFS that will benefit its associated surveys are briefly highlighted below.

The sample reallocation resulting in a shift of sample from NSR to SR areas will be more robust for general applications and in particular will improve estimation of income and rent changes from the SCF and Rent Survey. Also, the general multivariate stratification using 17 variables adopted (in both NSR and SR areas) will also represent an improvement for non-LFS applications.

Surveys using different sets of households will benefit from a shortened lead time for drawing samples due to the elimination of a stage of

sampling in rural areas and from increased flexibility to select subsamples of virtually any size.

Finally the planned use of a household size distribution in the ratio adjustment will improve family based statistics.

10. Summary of Changes and Future Plans

Improvements in the process of redesign included the use of 1981 Census data in place of independently obtained field counts, the reduction of the clustering operation, and automation of stratification and PSU formation. Also cost savings will result from introducing much of the new sample and dropping one rotation group at a time over a 6 month period, as compared with the traditional method of keeping the old sample at full strength for a 3-4 month period while building up the new sample. Process cost savings as compared with the previous redesign are estimated at $1.8 million (in 1983/84 dollars).

Principal improvements in the cost efficiency of the LFS survey design include the extension of telephone interviewing to months 2-6 in the sample in NSR areas, the adoption of an NSR design featuring explicit urban/rural stratification, elimination of a stage of rural sampling, the general purpose stratification in both SR and NSR areas, the use of subprovincial population controls in the estimation procedures. These improvements were sufficient to permit gains in the reliability of subprovincial data, while retaining the status quo for provincial level reliabilities, and while decreasing the overall sample size by 6-7%. Reliability gains averaged 14% for coefficients of variation of unemployed for the half of the Economic Regions and CMAs with poorest reliabilities under the old design, with for the most part, little or no change in remaining areas. Subprovincial gains for estimates of employed will be even greater. On the cost side, the sample size decrease, coupled with the telephone interviewing will result in estimated cost savings of $0.7 million per year (1983/84 dollars).

Following the completion of the sample redesign a principal focus of design related research and development for the LFS in coming years will be on investigation of a dual frame methodology, under which a portion of the sample would be converted to a telephone frame.

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REFERENCES

Choudhry, G.H., Drew, J.D. and Lee, H., (1984). "Cost Variance Optimization for the Canadian Labour Force Survey". Technical Report, Statistics Canada.

Drew, J.D., Choudhry, G.H. and Gray., (1978). "Some Methods for Updating Sample Survey Frames and Their Effects on Estimation", Survey Methodology, 4, pp. 225-263.

Drew, J.D., Singh, M.P. and Choudhry, G.H. (1982). "Evaluation of Small Area Estimations Techniques for the Canadian Labour Force Survey", Survey Methodology, 8, pp. 17-47.

Fellegi, I.P., Gray, G.B. and Platek, R. (1967). "The New Design of the Canadian Labour Force Survey". Journal of the American Statistical Association, 62, pp. 421-453.

Foy, P., Bélanger, Y., Drew, J.D. Joncas, M., (1984). "Multivariate Clustering Algorithm for Stratification and its Application to the Canadian Labour Force Survey". Technical Report, Statistics Canada.

Friedman, H.P. and Rubin, J., (1967). "On some Invariant Criteria for Grouping Data". Journal of the American Statistical Association, 62, pp. 1159-1178.

Hartley, H.O. and Rao, J.N.K. (1962). "Sampling with Unequal Probabilities without Replacement". Annals of Mathematical Statistics, 33, pp. 350-374.

Huang, E. and Ernst, L. (1981). "Comparison of an Alternate Estimator to the Current Estimator in CPS". Proceedings of the Section on Survey Research Methods, American Statistical Association, pp. 303-308.

Keyfitz, N. (1951). "Sampling with Probabilities Proportional to Size: Adjustment for Changes in the Probabilities". Journal of the American Statistical Association, 46, pp. 105-109.

Keyfitz, N. (1957). "Estimates of Sampling Variance where two Units are Selected from each Stratum". Journal of the American Statistical Association, 52, pp. 503-510.

Kumar, S. and Lee, H. (1983). "Evaluation of Composite Estimation for the Canadian Labour Force Survey". Survey Methodology, Vol. 9, No. 2, pp. 178-201.

Lemaître, G. (1983). "Some Results from the Time and Cost Study". Technical Report, Methodology Branch, Statistics Canada.

Paul, E.C., and Lawes, M. (1982). "Characteristics of Respondent and Non-Respondent Households in the Canadian Labour Force Survey". Survey Methodology, Vol. 8, pp. 48-85.

Platek, R. and Singh, M.P. (1976). "Methodology of the Canadian Labour Force Survey". Catalogue No. 71-526, Statistics Canada.

Platek, R. and Singh, M.P. (1977). "A Strategy for Updating Continuous Surveys". Metrika, Vol. 25, pp. 1-7.

Rao, J.N.K. (1975). "Unbiased Variance Estimation for Multi Stage Designs". Sankhya, Series C, Vol. 37, No. 3, pp. 133-179.

Rao, J.N.K., Hartley, H.O. and Cochran, W.G. (1962). "On a Simple Procedure of Unequal Probability Sampling without Replacement". Journal of the Royal Statistical Society, 24 (2), pp. 482-490.

Singh, M.P., and Drew, J.D. (1981). "Research Plans for the Canadian Labour Force Survey". Proceedings of the Section on Survey Research Methods, American Statistical Association.