Journal of Official Statistics, Vol. 13, No. 1, 1997, pp. 29–39

Effects of Post-Stratification on the Estimates of the Finnish Labour Force Survey

Kari Djerf[1]

In Finland, two competing unemployment statistics are published monthly. Their estimates differ from each other in a very systematic manner: the Labour Force Survey (LFS) estimates are lower than the register counts. This article examines the estimation procedures used in the LFS. We focus on the effects of the present post-stratification procedure. In addition, we investigate the possibility of obtaining more precise estimates by using auxiliary information derived from registers. As a result, we suggest that the present estimation procedure be replaced by the incomplete post-stratification (or generalized raking) method.

Key words: Post-stratification; generalized raking estimation; auxiliary information; nonresponse bias.

1. Introduction

In many countries, more than one set of different official statistics are published on the labour force and unemployment. In Finland, we have three main data sources, which is by no means exceptional internationally (see e.g., White and Leyland 1992). For the Labour Force Survey (LFS) Statistics Finland collects monthly data on employment, unemployment, hours worked, etc., in accordance with the ILO standards. The Ministry of Labour also publishes monthly figures on unemployed job seekers from its register (Employment Service Statistics). Statistics Finland compiles a set of annual register-based data on employment (Register-Based Employment Statistics). The contents of these statistics have been evaluated by Laihonen (1991).

The two monthly unemployment series differ considerably from each other (see the figure below). The register almost invariably produces higher unemployment figures than the LFS. The difference has increased since the onset of the economic recession in 1990 and by 1996 amounted to nearly 40,000 individuals, i.e., 10%. Such a wide gap is embarrassing, although careful examination has revealed many of the reasons (Statistics Finland 1992). In the present study, we discuss many of the factors that account for a major part of the total difference. Firstly, the register is not always current since those who are unemployed are not required to report to the Employment Office at short intervals. Secondly, each concept refers to a different point in time: the survey measure is collected

[1] Senior Researcher, P.O. Box 5A, FIN-00022 Statistics Finland, Helsinki, Finland.
Acknowledgments: I would like to thank Carl-Erik Särndal, Erkki Pahkinen, two anonymous referees and my colleagues for their helpful comments on earlier versions of this article. The views expressed are those of the author and do not necessarily reflect the views or practices of Statistics Finland. This research was supported in part by the Academy of Finland's Grant no. 33787.

© Statistics Sweden

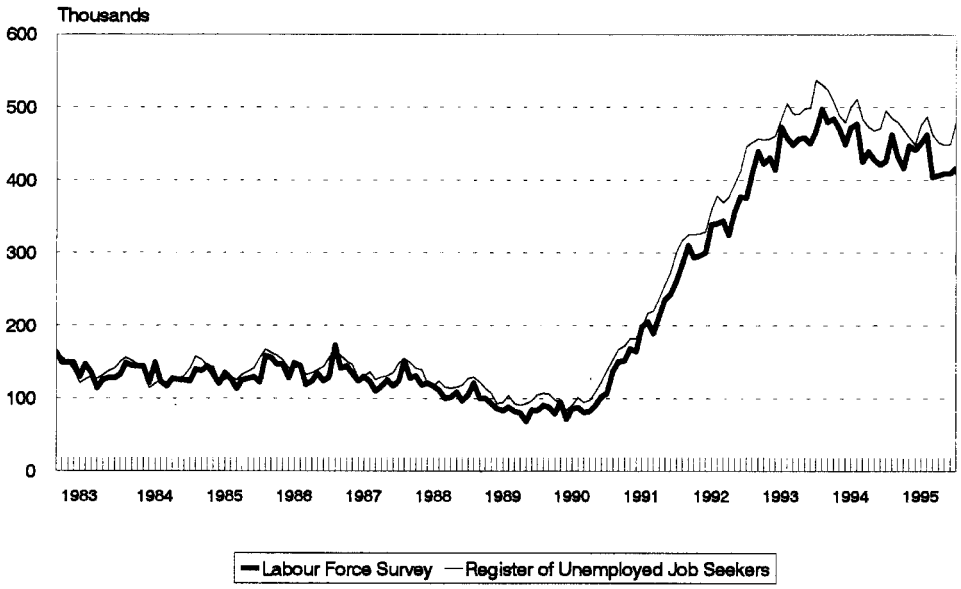

Fig. 1. Number of unemployed in the Labour Force Survey and in the Register of Job Seekers monthly, 1983–1995

from the week around the 15th of the month whereas the register figure is compiled for the last working day of each month. Thirdly, the LFS naturally contains sampling variation and nonresponse. There may also be other sources of variation. Normally, the LFS series is considered a more sensitive measurement instrument because of the ILO definitions.

Even theoretically the two figures do not coincide except by chance and the size of the difference prompted us to delve deeper into the LFS estimation procedure. The aim of this study is to obtain information on how the precision and efficiency of Finnish Labour Force Survey estimates can be improved. Additionally, we investigate whether there exists nonresponse bias in the data set and if so, how it could be reduced. This study extends the preliminary results obtained by Djerf and Väisänen (1993).

2. Sampling Design and Post-Stratification

The target population of the Labour Force Survey consists of the resident population in the ages 15–74. The sample is drawn from the Central Population Register by systematic sampling, which in this case amounts to simple random sampling without replacement (SRSWOR). The frame (list) is sorted by a unique address code and by age. In this case, systematic sampling yields a sample with an implicit proportional stratification according to population density.

The sampling design employed is a rotating panel design: each person is interviewed five times in the course of 15 months. The time lag between the interviews is 3 months, with the exception of a single 6-month lag. The rotating panel design ensures the independence of the monthly samples in each 3-month period, whereas there is much overlap across longer intervals (see Appendix). The pooled samples of two consecutive quarters contain 60% of the individuals who have been interviewed twice. The pooled sample

for one year contains 90% of the individuals who have been interviewed at least twice. The gross sample size is about 12,500 persons, one-fifth of whom are in the sample for the first time. For a more detailed description of the sampling structure, see Salmi and Kiiski (1984).

A detailed post-stratification scheme is used in weighting. The strata are constructed by sex, age, and province, totalling 312 cells. Some cell counts are below the ''common rule'', say 20 (see Cochran 1977, p. 134, for instance). The main advantage in using such detailed post-strata lies in the achievement of a high level of accuracy for various subgroup populations. Another advantage may be a reduction in nonresponse bias.

The data for March, April, and May 1993 were arbitrarily chosen for the study. The sample sizes ranged from 12,700 to 12,800. The response rates, too, remained stable, at about 94% on average. The target population totalled about 3.8 million at the time of the survey.

3. Comparison of the Results from Different Post-Stratification Schemes

To analyse the adequacy of the present post-stratification, we considered a number of potential stratification variables. We started from the most basic applicable method, i.e., SRSWOR and combined it with different post-stratification variables. The three parameters to be estimated were the size of the labour force, number of unemployed persons and unemployment rate. Besides the estimate for the total population, the estimates were also calculated for some subpopulations. Hörngren (1992) describes a similar study using the Swedish LFS data.

3.1. The current post-stratification

Djerf and Väisänen (1993) report that the current stratification procedure yields gains in accuracy for only the larger subgroups, such as those in the labour force or those not in the labour force. The results for domains which coincide with post-strata are more precise than the overall total. Some of the results are represented in the table below. The regional domains consist of service-intensive areas (Greater Helsinki), industrial areas (Häme Province) and sparsely populated, rural areas (Pohjois-Karjala Province). The age categories were selected to represent people of both working age and entering or leaving the labour market.

We used conditional variance estimators for post-stratification (cf. Holt and Smith 1979; Smith 1990). The difference between the conditional and the unconditional estimates was negligible. The calculations were performed using the CLAN program (Andersson and Nordberg 1994, 1996).

The labour force estimates were fairly precise. The deff-coefficient for the overall total was 0.6, dropping below 0.2 in some domains and averaging 0.33. But the estimates for the number of unemployed and the unemployment rate did not gain in precision. In fact, their precision was of about the same magnitude as in simple random sampling.

None of the basic stratification variables could improve the precision of the unemployment estimates as compared with the SRSWOR. The levels of the estimates of study variables were of course more accurate when post-stratification was used (Djerf and Väisänen 1993). Our conclusion was that the basic variables did not fulfil the purpose

Table 1. Ordinary LFS estimates for selected domains, March 1993

Domain	Labour force	Number of unemployed	Unemployment rate, in per cent
Total	2,431,285	422,091	17.4
	$cv = 0.52$, $deff = 0.57$	$cv = 2.56$, $deff = 1.01$	$cv = 2.49$, $deff = 1.00$
Male	1,276,273	250,169	19.6
	$cv = 0.67$, $deff = 0.28$	$cv = 3.33$, $deff = 1.00$	$cv = 3.24$, $deff = 1.01$
Female	1,155,012	171,922	14.9
	$cv = 0.80$, $deff = 0.34$	$cv = 4.01$, $deff = 0.90$	$cv = 3.90$, $deff = 0.99$
Greater Helsinki area	$cv = 1.17$, $deff = 0.24$	$cv = 7.22$, $deff = 1.10$	$cv = 7.11$, $deff = 1.00$
Häme province	$cv = 1.26$, $deff = 0.19$	$cv = 6.02$, $deff = 0.86$	$cv = 5.84$, $deff = 1.00$
Pohjois-Karjala province	$cv = 3.21$, $deff = 0.26$	$cv = 14.00$, $deff = 1.00$	$cv = 13.46$, $deff = 1.16$
Age 15–19	$cv = 6.20$, $deff = 0.72$	$cv = 12.41$, $deff = 0.87$	$cv = 10.66$, $deff = 1.05$
Age 25–29	$cv = 1.42$, $deff = 0.21$	$cv = 6.70$, $deff = 0.83$	$cv = 6.57$, $deff = 0.98$
Age 40–44	$cv = 0.77$, $deff = 0.08$	$cv = 6.67$, $deff = 0.89$	$cv = 6.63$, $deff = 1.00$
Age 60–64	$cv = 6.39$, $deff = 0.74$	$cv = 23.20$, $deff = 0.97$	$cv = 22.19$, $deff = 1.03$

of stratification, which is to minimize variation within cells and to maximize it between cells (see, e.g., Särndal, Swensson, and Wretman 1992, pp. 266–268). There were differences between the strata, such as considerable variation in unemployment rates according to sex, age, and region. Nevertheless, these variables did not sufficiently influence precision.

3.2. Register-based auxiliary information

Next, data from two registers were merged with the LFS data. The registers were the Register of Job Seekers maintained by the Ministry of Labour, and the Register-Based Employment Statistics of Statistics Finland. The idea was to check the extent to which the estimation of labour force participation (especially unemployment) could be improved and examine means of addressing bias due to nonresponse. The register information was merged in all cases, including nonrespondents. We used the personal identification number as a key. The basic idea was similar for both registers: only two post-strata were calculated instead of the original 312 strata.

3.2.1. Register of Job Seekers

The Ministry of Labour keeps a register of job seekers, in particular of all unemployed job seekers receiving unemployment benefits. According to the Ministry of Labour, the number of registered unemployed job seekers was about 455,200 in March, 456,600 in April and 461,200 in May 1993. The unemployment rates are also published by the Ministry of Labour but are not presented here; the Ministry's calculation method is flawed in that it simply uses the LFS estimates on labour force from the same quarter in the previous year.

The contents of the register are limited for our purposes. Consequently, the information on whether a person is an unemployed job seeker was the only information that could be

Table 2. The estimates from the LFS for the register definition of unemployment. (Note: the estimates here refer to the register from the end of the previous month, so that data for the estimated register count for March were obtained from the April LFS data)

Month	Register count	Ordinary LFS estimate (respondents)	Full sample LFS estimate (respondents + nonrespondents)
February 1993	457,453	440,458 (418,848 … 462,068)	453,631 (432,647 … 474,794)
March 1993	455,223	431,223 (409,764 … 452,682)	451,882 (430,763 … 473,008)
April 1993	456,393	424,943 (403,548 … 446,337)	445,878 (424,885 … 466,870)

used. A simple dummy variable was created for matching LFS unemployment with register unemployment: 1 if the person was found to be an unemployed job seeker, 0 otherwise.

The register dummies were calculated for the last day of each month for use with the next month's LFS data. A total of 1,318 respondents in the May 1993 LFS were matched with the April 1993 Register. The results were that 1,071 (81%) were unemployed according to both the LFS and the register, whereas 195 (15%) were employed and the rest were outside the labour force according to the LFS. The hit rate was about the same as that reported by Laihonen (1991, p. XI). We then compared various time lags, of 2, 6, 10 and 14 weeks. In May 1993, the correlations between the LFS unemployment cases and the register-based dummies were: January (14 weeks) 0.62, February (10 weeks) 0.68, March (6 weeks) 0.74 and April (2 weeks) 0.80. Exact date dummies could enable us to improve the correlation beyond 0.85, but unfortunately, they cannot be adapted for use in continuous statistics production. However, it would be possible to use either one of the two shortest lags (2 or 6 weeks) in the dummies.

An alarming feature was the possible existence of nonresponse bias. According to the register information, the proportion of unemployed persons among the nonrespondents was nearly double than among the respondents (19.4% vs. 11.1% under the register concept of unemployment). The same ratio had been found in earlier studies (Laihonen 1991; Statistics Finland 1992). During times of low rates of unemployment, the bias was probably not considered important enough to be taken into account in estimation. Nevertheless, the magnitude of the bias remained, and as unemployment increased, the bias exacerbated the existing problem in estimating the number of unemployed people.

In order to examine the existence of nonresponse bias we conducted a small experiment. The study variable was the register definition of an unemployed job seeker. The design was the following: first estimate the number of unemployed job seekers by using the current post-stratification. Secondly, recalculate the post-stratified weights for the total sample including the nonrespondents and estimate the count. The results above show that for two out of three months the estimates obtained by the current LFS post-stratification failed to contain the true value within the 95% confidence region. This situation changed when the nonrespondents were added and the full sample weights were applied. All estimates stayed close to the true values. We can therefore conclude that the current

post-stratification provides biased estimates at least for the register definition of unemployment. And because of a rather strong correlation between the two unemployment concepts this empirical finding is also a strong indicator of nonresponse bias for the LFS concept of unemployment.

3.2.2. Register-Based Employment Statistics

This register is compiled and maintained primarily for the purpose of providing users with longitudinal data on labour flows. It has fairly rich contents, but unfortunately a bit outdated. For this study, we used the register from 1991. Only variables relating to the status of the labour force were merged with the LFS data. A dummy variable was created indicating the person's labour force participation in 1991: 1 if the person was in the labour force, 0 otherwise. Despite a lag of more than a year, the indicator worked fairly well – the correlation with the LFS labour force participation rate was about 0.85 for all three months. For nonrespondents, the participation rate was lower, about 55%.

The effects of auxiliary information from different sources are presented in the table below.

Using the Register of Unemployed Job Seekers improved the precision of unemployment estimates considerably. In terms of the coefficient of variation, the improvement ranged from 30% to 40% a month. On the other hand, register information made the labour force estimates slightly more inefficient.

The 1991 register for Register-Based Employment Statistics improved the precision of the labour force estimates for March 1993 by 10 percentage points but did not improve the unemployment estimates at all. It seems that the maximum gain could be achieved by using more sophisticated indicators derived from the register, e.g., a main activity classification combined with the type of industry (cf. Hörngren 1992).

So, real improvement in the precision of unemployment estimates was achieved by using auxiliary information from the register of job seekers. It would have been desirable

Table 3. LFS estimates using register information in post-stratification, March 1993

Design	Labour force	Number of unemployed	Unemployment rate, in per cent
Full post-stratification (312 strata)	2,431,285 $cv = 0.52, deff = 0.57$	422,091 $cv = 2.56, deff = 1.01$	17.4 $cv = 2.49, deff = 1.00$
Reg. of job seekers Jan. 1993 (2 strata)	2,406,817 $cv = 0.67, deff = 0.95$	435,711 $cv = 1.74, deff = 0.50$	18.1 $cv = 1.76, deff = 0.50$
Reg. of job seekers Feb. 1993 (2 strata)	2,405,678 $cv = 0.67, deff = 0.94$	433,537 $cv = 1.54, deff = 0.39$	18.0 $cv = 1.59, deff = 0.44$
Annual reg.-based employment stat. (1991) (2 strata)	2,423,607 $cv = 0.47, deff = 0.47$	417,325 $cv = 2.57, deff = 1.00$	17.2 $cv = 2.49, deff = 0.99$
SRSWOR	2,397,086 $cv = 0.69, deff = 1$	414,439 $cv = 2.59, deff = 1$	17.3 $cv = 2.50, deff = 1$

to combine this variable with the original post-stratification in order to preserve the balance in population distributions. However, that would have proved intractable as the expected cell counts would theoretically have decreased below 20 in all post-strata. For this reason, we sought other solutions.

4. Incomplete Post-Stratification

The advantage of post-stratification is that the distributions of the post-stratifying variables coincide with the known distributions both on the marginals and the joint distributions. The feature of keeping the marginal distributions correct is retained by using incomplete post-stratification (or generalized raking). This method has been presented by Deville and Särndal (1992), and Deville, Särndal, and Sautory (1993).

We used equal weights for all respondents as design weights. This solution can be justified theoretically by a feature of weight calibration: the original weights to be calibrated should be as design unbiased as possible (Deville et al. 1993). The basic sampling method of the LFS can be regarded as a special case of simple random sampling.

The marginal distributions for calibration were:

1. marginal distribution of the target population by sex
2. marginal distribution of the target population by age category (12 categories: 15 to 19, 20 to 24, etc.)
3. marginal distribution of the target population by province (13 categories consisting of 12 provinces and the Greater Helsinki area)
4. the register count of the unemployed job seekers by the Ministry of Labour (2 categories)
5. the register count of the size of labour force according to the Register-Based Employment Statistics 1991 (2 categories).

Table 4. LFS estimates for selected domains using the incomplete post-stratification, March 1993

Domain	Labour force	Number of unemployed	Unemployment rate
Total	2,434,837	435,085	17.9
	$cv = 0.43$, $deff = 0.40$	$cv = 1.54$, $deff = 0.39$	$cv = 1.53$, $deff = 0.40$
Male	1,273,172	254,884	20.0
	$cv = 0.75$, $deff = 0.35$	$cv = 2.69$, $deff = 0.67$	$cv = 2.62$, $deff = 0.69$
Female	1,161,665	180,201	15.5
	$cv = 0.86$, $deff = 0.39$	$cv = 3.40$, $deff = 0.71$	$cv = 3.29$, $deff = 0.76$
Greater Helsinki area	$cv = 1.44$, $deff = 0.37$	$cv = 6.89$, $deff = 1.08$	$cv = 6.73$, $deff = 0.97$
Häme province	$cv = 1.63$, $deff = 0.34$	$cv = 5.72$, $deff = 0.83$	$cv = 5.49$, $deff = 0.94$
Pohjois-Karjala province	$cv = 3.29$, $deff = 0.39$	$cv = 13.35$, $deff = 0.90$	$cv = 12.73$, $deff = 1.04$
Age 15–19	$cv = 6.08$, $deff = 0.70$	$cv = 11.96$, $deff = 0.85$	$cv = 10.31$, $deff = 1.02$
Age 25–29	$cv = 1.38$, $deff = 0.20$	$cv = 6.44$, $deff = 0.83$	$cv = 6.29$, $deff = 0.97$
Age 40–44	$cv = 0.75$, $deff = 0.08$	$cv = 6.37$, $deff = 0.88$	$cv = 6.32$, $deff = 0.97$
Age 60–64	$cv = 6.29$, $deff = 0.73$	$cv = 23.16$, $deff = 0.96$	$cv = 22.30$, $deff = 1.02$

The French program CALMAR was used for calculating raking ratio weights (Sautory 1993) and the new version of CLAN for calculating approximate standard errors (Andersson and Nordberg 1996).

It appeared that practically all the favourable features of the original post-stratification could be maintained by adding register information and by using calibration. The method ensured correct marginal counts for administrative purposes. And more importantly, it improved the efficiency of the total unemployment estimate considerably.

These results are presented in Table 4, which is directly comparable with Table 1.

The use of data older than one month from the register of job seekers resulted in less effective estimates. However, efficiency of the estimate for total number of unemployed improved by more than 30% over the original unemployment estimate.

One must notice that in those domains (usually large) where the correlations between the auxiliary variables and the study variables remain strong we can expect substantial gains in precision. But the weaker the regression effect, the larger the standard errors will be (see, e.g., Estevao, Hidiroglou, and Särndal 1995, pp. 191–195). Therefore the precision could be improved by using as detailed auxiliary information as possible.

One source of improved efficiency can be attributed to the reduction in the variation of the weights, which decreased by one-half in terms of its standard deviation. For example, the coefficient of variation (*cv*) of the calibrated weights was 8% and the *cv* for the current post-stratification was 16% in March 1993.

The raking ratio technique might in certain circumstances yield biased estimates (see Oh and Scheuren 1987). Especially, one should take into consideration the lack of interactions. For this reason, we also calculated the conditional bias (see Deville et al. 1993, pp. 1017–1018). These bias terms appeared to be close to zero (0.012 for the labour force and -0.141 for the number of unemployed).

Unemployment estimates grew considerably for all three months (see the table below). Two conclusions can be drawn here. Firstly, the use of auxiliary register data reduced the gap between the two official unemployment estimates. The register-based count may or may not be within the 95% confidence interval of the improved estimate. Secondly, the ordinary estimates and the improved estimates differ so much that they do not seem to fit each other's confidence intervals. The ordinary estimates can be judged biased towards the employed.

Table 5. Comparison of unemployment estimates (95% confidence intervals in brackets)

Month	LFS, ordinary est.	LFS with register information	Register of job seekers
March 1993	422,100 (400,500 … 443,700)	435,100 (421,900 … 448,300)	455,200
April 1993	431,500 (409,500 … 453,500)	450,400 (437,300 … 463,500)	456,600
May 1993	414,700 (393,100 … 436,300)	440,300 (427,100 … 453,500)	461,200

5. Nonresponse Considerations

Nonresponse clearly affected the results. We tried to seek a response probability model in the spirit of Ekholm and Laaksonen (1991). However, it turned out that the resulting logistic regression model was unsatisfactory in predicting the outcome of the cases. The McFaddens pseudo-R^2 was only 0.05 (see, e.g., Dhrymes 1986, p. 1585 for the formula).

Post-stratification is known to reduce nonresponse bias (e.g., Jagers 1986; Bethlehem 1988). It was obvious that the probable bias in unemployment figures could be reduced (see Table 3) with correct post-stratification variables. The effect is similar in incomplete and ordinary post-stratification: if the data set can be divided into homogenous ''strata'' with response probabilities, the nonresponse bias will be reduced. The incomplete post-stratification method is perhaps stronger in fighting nonresponse bias because practically all important variables can be selected for calculating weights. For this reason, the additional adjustment from the logistic response probability model had only a negligible effect on the calibrated estimates.

6. Conclusions

Our results show that the use of auxiliary information improved the LFS estimates substantially. As regards the number of unemployed persons, the use of information from the Register of Job Seekers as the only stratification variable was more effective than the ordinary estimation. The need to preserve the population structure compelled us to use incomplete post-stratification (or generalized raking) estimators. And more importantly, we could probably increase the accuracy of the estimates by reducing the bias, a bias which appeared to be related to only one of the auxiliary variables considered in the study. Therefore we would like to suggest that the current post-stratification of the Finnish Labour Force Survey should be replaced by a more efficient one.

Appendix 1. The rotation structure of the Finnish Labour Force Survey for 1994 and 1995. The code refers to the year and month when each subsample first entered the panel.

	Subsample				
1994	1	2	3	4	5
January	9401	9310	9307	9301	9210
February	9402	9311	9308	9302	9211
March	9403	9312	9309	9303	9212
April	9404	9401	9310	9304	9301
May	9405	9402	9311	9305	9302
June	9406	9403	9312	9306	9303
July	9407	9404	9401	9307	9304
August	9408	9405	9402	9308	9305
September	9409	9406	9403	9309	9306
October	9410	9407	9404	9310	9307
November	9411	9408	9405	9311	9308
December	9412	9409	9406	9312	9309

1995

January	9501	9410	9407	9401	9310
February	9502	9411	9408	9402	9311
March	9503	9412	9409	9403	9312
April	9504	9501	9410	9404	9401
May	9505	9502	9411	9405	9402
June	9506	9503	9412	9406	9403
July	9507	9504	9501	9407	9404
August	9508	9505	9502	9408	9405
September	9509	9506	9503	9409	9406
October	9510	9507	9504	9410	9407
November	9511	9508	9505	9411	9408
December	9512	9509	9506	9412	9409

7. References

Andersson, C. and Nordberg, L. (1994). A Method for Variance Estimation of Non-Linear Functions of Totals in Surveys – Theory and a Software Implementation. Journal of Official Statistics, 10, 395–406.

Andersson, C. and Nordberg, L. (1996). New Features of CLAN9510. Statistics Sweden (mimeo in Swedish).

Bethlehem, J.G. (1988). Reduction of Nonresponse Bias Through Regression Estimation. Journal of Official Statistics, 4, 251–260.

Cochran, W.G. (1977). Sampling Techniques, 3rd ed. New York: John Wiley and Sons.

Deville, J.-C. and Särndal, C.-E. (1992). Calibration Estimators in Survey Sampling. Journal of the American Statistical Association, 87, 376–382.

Deville, J.-C., Särndal, C.-E., and Sautory, O. (1993). Generalized Raking Procedures in Survey Sampling. Journal of the American Statistical Association, 88, 1013–1020.

Dhrymes, P.J. (1986). Limited Dependent Variables. In Handbook of Econometrics, Vol. III, Z. Griliches and M.D. Intriligator (eds), Amsterdam: North-Holland.

Djerf, K. and Väisänen, P. (1993). Effects of Post-Stratification on the Estimates of the Finnish Labour Force Survey. International Statistical Institute 49th Session, Contributed Papers, Book 1. Firenze: ISI, 375–376.

Ekholm, A. and Laaksonen, S. (1991). Weighting via Response Modeling in the Finnish Household Budget Survey. Journal of Official Statistics, 7, 325–337.

Estevao, V., Hidiroglou, M.A., and Särndal, C.E. (1995). Methodological Principles for a Generalized Estimation System at Statistics Canada. Journal of Official Statistics, 11, 181–204.

Holt, D. and Smith, T.M.F. (1979). Post-Stratification. Journal of the Royal Statistical Society, Ser. A, 142, 33–46.

Hörngren, J. (1992). The Use of Registers as Auxiliary Information in the Swedish Labour Force Survey. Proceedings of the Workshop on Uses of Auxiliary Information in Surveys, October 5–7, Statistics Sweden and the University of Örebro, Örebro.

Jagers, P. (1986). Post-Stratification Against Bias in Sampling. International Statistical Review, 54, 159–167.

Laihonen, A. (1991). The Unemployed in Administrative Statistics and in the Labour Force Survey in Finland. Bulletin of Labour Statistics, 1991–3, IX–XIII.

Oh, H.L. and Scheuren, F.J. (1987). Modified Raking Ratio Estimation. Survey Methodology, 13, 209–219.

Salmi, H. and Kiiski, S. (1984). Developing the Quality of the Labour Force Survey. The Finnish Approach. Statistical Review, 16–26.

Sautory, O. (1993). La macro CALMAR. Redressement d'un échantillon par calage sur marges. I.N.S.E.E., Série des documents de travail n°F 9310. Paris: I.N.S.E.E. (in French).

Smith, T.M.F. (1990). Post-Stratification. The Statistician, 40, 315–323.

Statistics Finland (1992). Discrepancies Between the Unemployment Figures Given by the Labour Force Survey and the Administrative Count. Report by a team from Statistics Finland and the Ministry of Labour, No. 131. Helsinki. (in Finnish, an English translation of the report can be obtained from Statistics Finland).

Särndal, C.-E., Swensson, B., and Wretman, J. (1992). Model Assisted Survey Sampling. New York: Springer-Verlag.

White, A. and Leyland, J. (1992). How Unemployment is Measured in Different Countries. Employment Gazette, September, 421–431.

Received June 1994
Revised October 1996