STATISTICS IN TRANSITION-new series, Summer 2012
Vol. 13, No. 2, pp. 243—260

APPLICATION OF ROTATION METHODS IN SAMPLE SURVEYS IN POLAND[1]

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ABSTRACT

The author reviews theory and application of rotation methods in sample surveys in Poland. He begins with reviewing designs of the surveys across time, depending on different objectives, focusing on partial rotation of sub-samples, and considers estimation problems and data quality issues generally. Next, he refers to some articles and books about surveys published over time, starting with Wilks (1940), Patterson (1950), Eckler (1955), Woodruff (1963), Rao and Graham (1964), Bailar (1975), Duncan and Kalton (1987) and Kalton and Citro (1993). He mentions also early Polish papers on rotation methods (Kordos (1966, 1967, 1971, 1982); Lednicki, 1982; Szarkowski and Witkowski, 1994), and concentrates on Polish household surveys, mainly Household Budget Survey (HBS), Labour Force Survey (LFS) and EU Statistics on Living Conditions and Income (EU-SILC). Special attention is devoted to last research on rotation sampling done by Polish sampling statisticians: Ciepiela et al. (2012), Kordos (2002), Kowalczyk (2002, 2003, 2004), Kowalski (2006, 2009), Kowalski and Wesołowski (2012) and Wesołowski (2010). Concluding remarks are given at the end.

Key Words: Rotation sampling; sampling on successive occasions; survey across time; panel survey; data quality; sample survey.

1. Introduction

At the beginning the author examines the interplay between sample survey theory and practice in Poland over approximately the past 50 years. He begins with the Neymans's (1934) classic landmark paper which laid theoretical foundations to the probability sampling (or design-based) approach to inference from survey samples. Main ideas of that paper were first published in Polish in

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[1] This is an extended and updated version of the paper connected with the author's paper entitled *"Interplay Between Sample Survey Theory and Practice in Poland"* presented at the Congress of Polish Statistics held in Poznań, Poland, 18-20 April 2012. The author concentrates here on application of rotation methods in sample surveys in Poland.

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1933 (Neyman, 1933) and had a significant impact on sampling practice in Poland before and after World War II. Sample surveys conducted in 1950s and 1960s were consulted with J. Neyman during his visits in Poland in 1950 and 1958 (Fisz, 1950; Zasepa, 1958).

Some practical problems encountered in the design and analysis of sample surveys were partly solved by the Mathematical Commission of the CSO which was established in 1949 as an advisory and opinion-making body to the CSO President in the field of sample surveys. The Commission concentrated specialists in the sampling methods both from the CSO and research centres in the country (Kordos, 1975, 2012). The Commission had a significant impact on sampling practice in Poland and was active until 1993.

Polish sampling statisticians had problems with sampling in time (household budget surveys, agricultural sample surveys, living conditions surveys) and some research works were devoted to rotation methods and panel surveys (Kordos, 1967, 1985). They had problems with size of sample determination, sample allocation and estimation methods (Bracha, 1996; Greń, 1964, 1966, 1970; Kordos, 1985, 1988a, 2002; Zasępa, 1962, 1970, 1993) and with data quality (Kordos, 1988bc). There were problems with calibration estimation that ensures consistency with user specific totals of auxiliary variables, unequal probability sampling without replacement, analysis of survey data (Kordos, Zięba-Pietrzak, 2010).

Very important and difficult problems for sampling practice are data for small areas. That is why Polish statisticians are interested in the issues related to estimation methods for small areas (Kalton et al., 1993; Domański and Pruska, 1996; Golata, 2012; Paradysz, 1998).

The Central Statistical Office of Poland (GUS) was deeply involved in rotation methods after consultation with Prof. Jerzy Neyman in 1958 (Zasepa, 1958), who criticized current application of sampling method in the panel household budget survey in Poland. Sampling statisticians in GUS, in cooperation with the Mathematical Commission of GUS (Kordos, 1975, 2012) have undertaken research in application of rotation methods in sampling surveys in Poland (GUS, 1972, 1979, 1987; Kordos, 1971, 1982, 1985, 1996; Lednicki, 1982).

Before presenting application of rotation methods in the sample surveys in Poland, I begin with reminding different objectives for surveys over time, appropriate survey designs for these surveys, estimation problems and data quality issues. General overview of issues in repeated surveys is also presented. Next, the involvement of the Central Statistical Office of Poland in theory and application of rotation methods in sampling surveys is presented.

2. Rotation sampling

The name „*rotation sampling*” (suggested by Wilks, 1940) refers to the process of eliminating some of the old elements from the sample and adding new elements to the sample each time a new sample is drawn. This method of sampling is also called *sampling on successive occasions with partial replacement of units* (Patterson, 1950; Yates, 1949) and *sampling for a time series* (Hansen, Hurwith and Madow, 1953). *Double sampling* can be regarded mathematically as rotation sampling involving a present sample and one overlapping an earlier sample.

In general, we have a population of units (segments) which is to be sampled for T consecutive periods (months, quarters, years). In any proposed sampling design, the units to be sampled can change from period to period but not at time points within the period. In addition, there is a positive correlation between the responses from a unit in consecutive time periods which can be utilized to reduce the standard errors of the estimators of the end of period means. The problem is to determine a T period sampling scheme which is optimal in some sense. Rotation designs are a natural starting point in the search for a solution of this problem.

In many repeated surveys, samples are collected routinely (e.g., monthly or quarterly) from a finite population, and the characteristics of the sampling units change over time. Many of these surveys also provide information on relevant auxiliary variables. Thus, it is possible to improve on the current direct survey estimators of the finite population parameters by using data from earlier surveys, in conjunction with the auxiliary variables. For example, consider the Household Budget Survey (HBS), the Labour Force Survey (LFS) and the Statistics of Living Conditions Survey (EU-SILC).

A similar situation may be cited in small-area estimation problems, which have received considerable attention in recent years (Rao, 2003). Estimate of a small area (finite population) characteristic may be improved by utilizing data from related areas and the auxiliary variables.

3. Objectives for surveys over time

Changes in population characteristics and composition over time lead to variety of objectives for surveys across time. These objectives include the following (Kalton and Citro, 1993):

a. Estimating population parameters at distinct time points.
b. Estimating average values of population parameters.
c. Estimating net change.
d. Estimating gross and others components of individual change.
e. Averaging data for individuals over time.
f. Collecting data on events occurring in specified time period.
g. Cumulating samples over time.
h. Keeping contact with members of a rare population identified at a point of time.

To estimate these parameters for different objectives from sample surveys there are various problems connected with sample design, size of sample, allocation of sampling units in space and time, collection of required data from these units, quality of obtained information, etc. Some of these problems may be partly solved by applying rotation sampling, i.e. changing sub-samples of units at different periods of time.

4. Survey designs over time

A number of survey designs have been developed to provide data to the address of the above mentioned objectives. These designs are (Duncan and Kalton, 1987; Kalton and Citro, 1993):

1) ***Repeated survey:*** a series of separate cross-sectional surveys conducted at different time points.
2) ***Panel survey***: collecting of the survey data for the same sample elements at different points of time.
3) ***Repeated panel survey***: is made up of a series of panel surveys, each of fixed duration:
   i. ***with no overlap*** (one panel may start only as the previous one ends),
   ii. ***with overlap*** (with two or more panels covering the same period of time).
4) ***Rotating panel survey:*** is equivalent to a repeated panel survey with overlap. Both limit the length of a panel and have two or more panels in the field at the same time. Rotating panel surveys are widely used to provide a series of cross-sectional estimates and estimates of net change, whereas repeated panel surveys with overlaps also have a major focus on longitudinal measurement. In consequence, repeated panel surveys tend to have longer duration and have fewer panels in operation at any given time than rotating panel surveys.
5) ***Split panel surveys***: is a combination of a panel survey and repeated survey or rotating panel survey.
6) ***Repeated survey with overlap***: like a repeated survey and overlapping survey, it is a series of cross-sectional surveys conducted at different time points, and is designed to provide overlaps.

The choice of design in a particular case depends on the desired objectives to be satisfied. Some designs are better than others for some objectives but less suitable for other objectives.

5. Reasons for sample rotation

Response burden among the households or other units can be reduced by periodic sample rotation. However, rotation of units increases the cost of the survey because of additional sample maintenance, possible additional training of interviewers, extra costs of initially collecting baseline information, and difficulties in training new units to provide data. Partial rotation of sampled units at some fixed rate is undertaken as a compromise between total rotation, i.e. 100% of units, that is very expensive and gives poor estimates of change and no rotation at all (panel) that would result in an unacceptable distribution of response burden. The rotation schemes keep a unit in the sample for a given period after which the unit becomes ineligible for re-selection by the same survey for a minimum period.

One can think of a rotation design as a compromise between a complete sample overlap and taking independent samples. Each extreme has advantages and disadvantages. By using a rotation design, one hopes to realize some of the variance reduction of the complete sample overlap, while reducing its excess burden.

However, it should be recognized that retention of the same units for a long series of surveys presents practical and theoretical difficulties since the frame is changing; repeated surveys on the same units may also lead to atypical changes in these units. The continuing operation of a survey agency on successive surveys of the same type also usually leads to a gradual improvement in the quality of the information.

6. Estimation problems

An objective of a survey over time is usually to estimate more than one population parameters. Very often several objectives given in section 3 are to be achieved. Two of many important choices that must be made in a survey are (Kordos, 2002):

i. The choice of sampling design and a sample selection scheme to implement the design.
ii. The choice of a formula (an estimator) by which to calculate an estimate of a given parameter of interest.

The two choices are not independent of each other. For example, the choice of the estimator will usually depend on the choice of sampling design. It is necessary to use an appropriate strategy.

A strategy is the combination of a sampling design and an estimator. For a given parameter, the general aim is to find the best possible strategy, that is one that estimates the parameter as accurately as possible.

In the above sections we note five objectives and six designs. Most periodic studies have several purposes and thus we should face – not necessarily solve – difficult problems of multipurpose designs. Actually, objectives from (a) to (c) can be met with any of the six listed designs, but in some they increase in the variances or in costs. But estimates with gross and individual change need panels, and objective (e) need some changes. Often reasonable compromises become possible – to the degree that purposes can be defined. The chief variation in these designs concerns the amount (and kind) of overlaps between periods (Kish, 1987, pp. 159 – 169).

Table 1. Purposes and Designs for Periodic Samples

Purposes	Designs	Rotation Scheme
A. Current levels	A. Partial overlaps 0<P,1	abc–cde–efg
B. Cumulating	B. Non-overlaps P = 0	aaa–bbb–ccc
C. Net changes (means)	C. Complete overlaps P = 1	aaa–aaa–aaa
D. Gross changes (individuals)	D. Panels	Same elements
E. Multipurpose, time series	E. Combination F. Master frames	

Source: Kish, 1987, p. 160.

The rotation scheme of complete overlaps shows, with aaa–aaa, that the periods have all common parts; the non-overlaps with aaa–bbb shows none, and the partial overlaps abc–cde–efg shows c and e as one-third overlaps between succeeding periods only.

Here, we concentrate on the effects of varying proportions P in divers designs on different purposes; in complete overlaps P = 1, in non-overlaps P = 0, and in partial overlaps 0<P<1. The purposes are discussed in terms of variances for estimated means, because means (and percentages, rates, proportions) are both the most used and the simplest estimates to be treated. Effects on other estimates will not be entirely different but they are too numerous, diverse and difficult to be explored here.

Effects on the variances of means from different portions P can be treated clearly in this brief section. Other questions of biases, of feasibility, of costs are often more important, but also more difficult. They are treated in all sampling books. We assume here for simplicity that the period samples are of the same size or of the same sampling fraction; but changes in sizes, fractions and designs are possible. We start below with current levels and partial overlaps.

6.1. Current levels and partial overlaps

Variances of current estimates are the same for complete overlaps P = 1 and non-overlaps P = 0; they can be expressed briefly for means as $Deft^2=S^2/v$, where $Deft^2$ is the effect of the sample design on either the element variance S^2 or the sample size *n* (Kish, 1987, p.162-163).

That simple formula also holds for *simple* means from partial overlaps (0<P<1). But statistics based on them can utilize the overlap P for a reduction of the variance with a complex mean: with help of the correlation R^2 between surveys within the same overlap P, the portion (1-P) of the *preceding* sample is combined with the current mean to improve it. The variances are reduced by the factor:

$$\frac{1-(1-P)R^2}{1-(1-P)^2R^2} \qquad \text{(Cochran, 1977, secs.12.11-12.12)}$$

The actual gains unfortunately tend to be modest in most practical situations, the maximum reduction in variance, utilizing optimal proportions P and optimal weights, is the ratio

$[1+((1-R^2)^{0,5}0]/2$. Reductions increase to about 33% only for very high R^2 values, seldom seen in practice; for R = 0.9, for example, $[1+((1-R^2)^{0,5}0]/2 = 0.72$. This ratio is obtained either with the optimal P = 0.30 or with P = 1/3. For R = 0.6 that ratio becomes 0.9, only 10 percent reduction of the variance. It is worth stressing that in a long series the complex mean from the preceding sample can already benefit from reductions from its predecessors, and that using a longer series provides further slight reductions. Fortunately, for other purposes of repeated surveys statistical theory is more productive as well as simpler.

6.2. Net changes of Means and Overlaps

Net change refers to the difference $d = \bar{x}_1 - \bar{x}_2$ of means between two periods, whereas *gross change* deals with the total changes of individuals, some of which remain hidden, because they cancel, in the net change of means. Measuring net changes are common and important aims of surveys, and they are also related to other issues of the data. Perhaps the most forms are differences in dichotomies, denoted by proportions d = p_1 -p_2, and in similar rates and ratios.

The variance of ($\bar{x} - \bar{y}$) can be greatly reduced when the pairs of variables have high positive correlation R in overlapping samples. We will discuss here several cases shortly.

1. The variance of mean differences are reduced by factors (1 – R) in complete overlaps; this is the extreme (with P = 1) of the factor (1 –PR) that may be obtained from the partial overlaps. Hence, for minimizing variance Var ($\bar{x} - \bar{y}$) complete overlaps would be the best. But partial overlaps are used in practice: for reasons of feasibility, to reduce burdens, fatigue, and biases of respondents; and reduce variances of other statistics in multipurpose designs.
2. We may obtain almost the full reductions of complete overlaps even from partial overlaps by using improved estimators of the differences. These estimators are useful when circumstances may present complex overlaps but still permit partial overlaps. In those estimators the overlaps portion P gets larger weights than the non-overlaps portion 1– P = Q, by the factor 1/(1–R), because elements in the overlap contribute much less to the variance. This improved estimator of the difference is (Kish, 1965, table 12.4. III):

$$\hat{D}(\bar{y}-\bar{x}) = [P(\bar{y}-\bar{x})_p + Q(1-R)(\bar{y}-\bar{x})]/(1-QR)$$

Its variance may be expressed, for two *srs* samples of size n, as:

$$Var([\hat{D}(\bar{y}-\bar{x})] = \frac{(1-R)S^2}{(1-QR)n}$$

The factor (1- R)/(1-QR) approaches (1-R) for high values of R and for higher values of P, say p = 2/3. High value of R are common for stable characteristics that can be well measured.

7. Overview of Issues in Repeated Surveys

Patterson (1950), following the initial work by Jessen (1942), provided the theoretical foundations for design and estimation for repeated surveys, using generalized least squares procedures. For the Current Population Survey, Hansen et al. (1955) proposed a simpler estimator, called the K composite estimator. Gurney and Daly (1965) presented an improvement to the K composite estimator, called the AK composite estimator with two weighting factors A and K. Breau and Ernst (1983) compared alternative estimators to the K composite estimator for the CPS. Rao and Graham (1964) studied optimal replacement schemes for the K composite estimator. Eckler (1955) and Wolter (1979) studied two level rotation schemes such as the one used in the U.S. Retail Trade Survey. Yansaneh and Fuller (1998) studied optimal recursive estimation for repeated surveys. Fuller (1990) and Lent, Miller, Cantwell and Duff (1999) developed the method of composite weights for the CPS. The composite weights are obtained by raking the design weights to specified control totals that included population totals of auxiliary variables and K composite estimates for characteristics of interest. Using the composite weights, users can generate estimates from micro-data files for the current month without recourse to data from previous months.

Ciepiela et al. (2012) propose a dynamic version of the K-composite estimator (DK-composite estimator) without any restrictions on the rotation pattern. This estimator gives an alternative solution to quasi-optimal estimation under rotation sampling when it is allowed that units leave the sample for several occasions and then come back. Such situations happen frequently in real surveys and are not covered by the recursive optimal estimator introduced by Patterson (1955). However, the K-composite estimator suffers from certain disadvantages. It is designed for a stable situation in the sense that its Basic parameter is kept constant on all occasions. Additionally, it is restricted only to a certain family of rotation designs. The authors propose a dynamic version of the K-composite estimator (DK-composite estimator) without any restrictions on the rotation pattern. Mathematically, the algorithm they develop is much simpler than the one for the classical K-composite estimator with optimal weights. Moreover, it is precise in the sense that it does not use any approximate or asymptotic approach (opposed to the method used in Rao and Graham (1964) for computing optimal weights).

The above authors used the traditional design based approach, assuming the unknown totals on each occasion to be fixed parameters. Other authors (Scott, Smith and Jones 1977; Jones 1980; Binder and Dick 1989; Bell and Hillmer 1990; Tiller 1989 and Pfeffermann 1991) developed estimates for repeated surveys under the assumption that the underlying true values constitute a realization of a time series.

8. Data quality issues

Survey data quality issues, is a concept with many dimensions linked with each others. In theory, all dimensions of data quality are very important, but in practice, it is usually not possible to place high importance on all dimensions. Thus, with fixed financial resources, an emphasis on one dimension will result in a decrease in emphasis on another. More emphasis on accuracy can lead to less emphasis on timeliness and accessibility, or emphasis on timeliness may result in early/preliminary release data of significantly lower accuracy. Each dimension is important to an end user, but each user may differ in identifying the most important priorities for a data collection program.

An extensive literature exists and continues to grow on the topic of survey data quality. Special attention to data quality has been paid in last years by Eurostat (2007, 2009), and relating to household surveys (e.g. Bailar, 1975, 1979; Brackstone, 1999; CPS, 2002; GUS, 1972, 1979, 1987, 2009; Kordos, 1988ab; Lyberg et al. 1997).

For a sample survey over time, the following sources of errors are very important:

a. Non-response losses,
b. Time-in-sample, or conditioning effects,
c. Recall errors, including the seam effect, and other non-sampling errors.

In Polish household surveys, such as the HBS, the LFS, and the EU-SILC, only sampling errors and non-response rates are reported. Conditioning effects, recall errors, the seam effects and other non-sampling errors are neglected. Additional research in these fields is needed.

9. Application of rotation sampling in the sample surveys of the Central Statistical Office of Poland (GUS)

We started applying rotation sampling in statistical sample surveys in 1960s, after the consultation with Prof. Jerzy Neyman (Kordos, 2011; Zasepa, 1958). At the beginning we studied such articles as Wilks (1940), Jessen (1942), Patterson (1950), Eckler (1955), Woodruff (1963), and Rao and Graham (1964), and books as Yates (1949), Deming (1950) and Hansen et al. (1953).

In 1967 I published a review paper on rotation method in sampling surveys (Kordos, 1967). Later the following articles describing application of rotation sampling were published by GUS (1969, 1972, 1979. 1987), Kordos (1966, 1971, 1982, 1988ab, 2002), Szarkowski and Witkowski (1994) and Popiński (2006).

Theory for applying rotation method in the Polish sample surveys was rather simple. First, we applied cross-sectional surveys, and were criticized for missing seasonal effects, and data related to generalized for a given year.

The following surveys were carried out with application of rotation sampling:

1) Rotation method in morbidity survey (1967 – 1968).
2) Time use surveys (1967, 1976, 1984, 1996).
3) Experiments of HBS by rotation method (1968 – 1969, 1981).
4) Surveys of workers starting first job (1971).
5) Epilepsy survey in Warsaw ((1971).
6) Household Budget Survey (since 1982 +).
7) Labour Force Survey (since 1992 +).
8) EU Statistics on Income and Living Conditions Survey (UE-SILC) (since 2005 +).

10. Some theoretical research in rotation sampling in Poland in the last decade

Factors affecting the design of a sample over time include the key estimates to be produced, the type and level of analyses to be carried out, cost, data quality and reporting load. The interaction between sampling over time and features of the design, such as stratification and cluster sampling also needs to be decided. Duncan and Kalton (1987), Kalton and Citro (1993) and Steel (2004) give a general review of issues in the design and analysis of repeated surveys. Kasprzyk *et al*. (1989) cover many of the important issues associated with panel surveys.

Several Polish statisticians have undertaken some research in rotation sampling in last decade. I would like to mention in a synthetic way some of the results of Ciepiela et al. (2012), Kowalczyk (2002, 2003, 2004), Kowalski (2006, 2009), Kowalski and Wesołowski (2012), Popiński (2006) and Wesołowski (2010). Ciepiela et al. (2012) contributions have been presented above.

Kowalczyk (2003) gives the theory for the estimation of the population total on the current occasion under two-stage sampling design with a partial replacement of the second stage units. Under given rotation pattern she presents composite estimator of the population total, which exploits information from the previous occasion. She derives the variance of the estimator and compares it with the variance of the usual estimator. It has been shown that the composite estimator is better than the usual one applied both for a sample selected independently of the previous period and a sample selected according to the given rotation pattern.

The aim of Kowalski (2009) paper is to examine the setting of surveys repeated over time when the elements in the sample are rotated in a pre-designed way. On each occasion the best linear unbiased estimator (BLUE) of the current population mean, built on all past responses is to be found. The most straightforward approach would be to compute the estimator as a solution of a least squares problem with linear restrictions. However, this method has certain drawbacks related to the fact that the size of the response data set increases over time. They follow a different approach based on finding linear recurrence relationships between optimal estimators obtained on successive occasions. Most of the original disadvantages are then corrected. In this context we present the solution to the BLUE estimation problem for some — sufficiently regular — classes of rotation patterns.

Kowalski and Wesołowski (2012) consider linear recurrence for BLUE estimators of the unknown population mean obtained on successive occasions. They work in the framework of sample rotation where evolution of the sample across time is pre-designed. It has been known since Patterson (1950) that the essential difficulties arise when it is allowed that units may return to the sample after being absent in the sample for several occasions. It means that contrary to the Patterson setting, holes in rotation patterns are allowed. These difficulties are to a large extent overcome in the present paper. They prove that under some assumptions, linear recurrence holds and its order is closely linked to the rotation scheme. Of special importance in this setting appear to be roots of certain polynomial conveniently expressed in terms of Chebyshev polynomials. An effective and easily implemental algorithm for calculation of the recurrence coefficients is given. It is illustrated through examples of rotation schemes which are used in concrete surveys.

Wesołowski (2010) paper is devoted to the Szarkowski's involvement in the Polish Labour Force Survey design, who observed that under the rotation pattern typical for the LFS the recursion for the optimal estimator of the mean on a given occasion has to use estimators and observations only from three last occasions. Since the fundamental work of Patterson (1950) it has been known that for rotation patterns with "holes" it is a difficult problem to determine the depth of such recursion formulas. Under special assumptions the problem has been settled only recently in Kowalski and Wesołowski (2012). In the present paper it is shown that these assumptions are always satisfied in the case of the Szarkowski rotation pattern 110011. Moreover, explicit formulas for the coefficients of recursion are derived. As the author has stressed "It took more than ten years to answer in affirmative Szarkowski's three steps conjecture. It is based on a general approach described in Kowalski and Wesołowski (2012 (KW in the sequel). Earlier the problem for rotation schemes with singleton holes was solved in Kowalski (2009) (particular cases of 1011 and 1101 rotation patterns were covered even earlier, in (2004)). Moreover, explicit formulas for the coefficients of the recursion are derived".

11. Concluding remarks

The aim of rotating panels is twofold: firstly, it allows increasing the precision of estimates of change between two different points in time and, secondly, producing flow estimates, thus allowing the calculation of important indicators for the analysis of dynamics characteristics. A further advantage is the possibility to make use of dependent interviewing to reduce non-response burden. However, rotating panels present the typical drawbacks of panels, although these problems are less critical in the light of the short panel duration. Possible drawbacks include panel attrition, panel conditioning and misreporting. Furthermore, because population evolves in time, the longer panels remain in the sample the more they diverge from the actual population's structure. Overlap between months or quarters may also cause some inefficiency in annual estimates. Besides, rotation can be the underlying cause of other problems, such as non-response and measurement inconsistencies between subsequent survey waves. Comparability of longitudinal data could also be of concern with different rotation schemes. Overall, however, the advantages of rotation patterns outweigh their disadvantages.

In this paper, I reminded objectives of surveys in time, sampling designs, estimation methods and data quality issues connected with such surveys. Next, general review of application of rotation methods in sample surveys in Poland, and some theoretical research of surveys over time were presented. However, more research is needed in the field of sampling design and data quality for surveys in time, taking into account sampling and non-sampling errors. In social surveys, such as HBS, LFS and EU-SILC collected data are biased for different reasons (e.g. non-response, measurement errors, response errors, etc.). In such cases, it is unreasonable to assess accuracy of results, using MSE or confidence intervals if additional efforts are not undertaken to improve accuracy of the collected data. For quality assessment, it seems reasonable to use only precision or relative standard error (CV). If a confidence interval must be used, then its interpretation should be changed, avoiding words “to cover the true value...”.

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