**Effects of the influence of calibration procedures on reliability of indicators estimated by the state household sample surveys in Ukraine**

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**Abstract**

*Sample weights calibration procedures are increasingly applying at the indicator estimation stage of the state household sample surveys. The practical purpose of calibrated estimation is to coordinate the results of surveys with the actual auxiliary information. This allows, on the one hand, to somewhat reduce the possible bias of estimates, and, on the other hand, to ensure matching of estimates with data from other sources. At the same time, calibration can lead to a significant decrease of the effective sample size and, accordingly, to a decrease of the accuracy of estimates.*

*For instance, in the State Household Living Conditions Survey (HLCS) provided by the State Statistics Service of Ukraine on quarterly basis, sample weights are calibrated using relatively large number of external sources. This is primarily the data of demographic statistics on the number and structure of the population, data on the number of households, including households with children. In the experimental mode the national accounting system data and the tax administration data are used. Taking into account that the HLCS is the main source of data for measuring of a number of significant indicators which reflect incomes, expenditures, consumption features, poverty of Ukrainian households it is important to estimate the impact of calibration on the reliability of key indicators.*

*The article presents materials of estimation of influence of calibration procedure on the quality of the statistical weights and on the reliability of indicators.*

**Keywords:** sample weights,calibration, reliability, bias

**1. Introduction**

Calibration of sample weights is increasingly used at the indicator estimation stage in state sample surveys. These procedures allow you to coordinate survey estimates with available reliable information from external sources, such as registers or continuous surveys. Calibration procedures make it possible also to refine results of a survey if, for instance, estimates obtained from statistical models are used as auxiliary information at the indicator estimation stage. This is achieved by adjusting the statistical weights (Deville, J.-C. and Särndal, C.-E. 1992). The advantage of using calibration methods is that they allow analysis by the full survey data set. The disadvantage is that the sample weights system is sometimes corrected very significantly and the calibration weights can be significantly differ from the design weights. In addition, the issue of estimation the reliability of survey indicators based on a microdata set using calibration weights becomes problematic. Linearization or replication methods based on calibrated weights show larger errors than errors based on design weights. This is primarily due to the greater variation of the calibration weights as compared to the design weights. However, the calibration is often carried out with the aim of reducing the errors in estimating the indicators, especially reducing the probable bias of estimates.

This article discusses some issues of estimation the reliability of indicators when using calibration procedures. As an illustration some results obtained on base of the data of the State Household Living Conditions Survey (HLCS) provided by the State Statistics Service of Ukraine (SSSU) are given.

**2. Methodological approach**

It’s known, that results of state sample surveys at the stage of indicator estimation in practice can be improved only by modifying the estimation procedures, primarily, the procedures for calculating the system of sample weights. The calibration procedure minimizes the distance between the calibrated weights and the design weights (Deville, J.-C. and Särndal, C.-E. 1992). The calibrated weights have to satisfy the conditions (restrictions) determined on the basis of the previously selected auxiliary information.

In the first stage calibration of the HLCS sample weights as auxiliary information is used population by strata (regions and area type), household numbers by strata, and age - sex structure of population (SSSU 2011). In addition, last two years the procedure for adjusting the reliability of the HLCS results is tested to better take into account living conditions of the well-to-do strata of the population (SSSU 2014). One approach for this is to calibrate the sample weights using the tax register data on the distribution of income for taxpayers and the data from the National Accounting System on the household’s disposable income at the regional level. Thus, a fairly complex calibrating procedure is implemented, which leads to a significant adjustment of the design weights.

Estimation of the reliability of HLCS indicators of base of the final calibrated weights leads to larger errors in estimating the indicators than on the basis of weights before calibration. This is due to increasing variability of the weights. But we understand that the aim of calibration, at least in case of adjustment to the well-off population, is decreasing of errors, primarily related to the estimation bias.

In our opinion in this situation it would be logical to use not only the final calibrated weights, but also the design weights (weights before calibration) when estimating the reliability of the indicators based on micro data set. Wherein on base of calibrated weights and design weights the bias of the estimates is determined, and on base of the final calibrated weights the variance of the sample estimates is defined. Then the reliability of an indicator $θ$ estimated using design weights will be defined on base of the mean squared error:

$MSE\left(\hat{θ}\right)=Var\left(\hat{θ}\right)+Bias(\hat{θ},θ)^{2}$ (1)

Thus, the gain in reliability of the indicator estimate $\hat{θ}$ on base of the calibrated weights will be determined by the difference between the square of the bias and the increase of the sample variance.

**3. Results**

The characteristics of design weights and calibrated weights in the HLCS 2016 are given in the table 1. As it can be seen from the table, in general, the quality of the weights is reduced, especially at the stage 2.

**Table 1.HLCS weightsquality characteristics**

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristic** | **Design****weights** | **Weights calibrated at stage 1** | **Weights calibrated at stage 2 (experimental)** |
| Maximum | 11881,0 | 13874.4 | 32094.7 |
| Minimum | 100,0 | 100,2 | 75,3 |
| Variance ($σ^{2}$) | 3406483.6 | 3717493.9 | 4951909.6 |

Source: author's calculations

The reliability of estimating the household’s average monthly total expenditures at the national level by HLCS 2016 data after the first stage calibration is at level of
$Var\left(\hat{θ}\right)$ = 2686.52 ($\hat{θ}$ = 5720.37 UAH per household, $cv\left(\hat{θ}\right)$ = 0.0091) (SSSU 2017).

After the second stage calibration the variance of the estimate increases approximately 1.2 times to the value of $Var\left(\hat{θ'}\right)$ = 3207.64 and the indicator estimate reached $\hat{θ'}$ = 6447.75 UAH. If we accept the difference in the estimates as estimate of the bias than $Bias(\hat{θ'},θ)$ = 782.04 UAH than $MSE\left(\hat{θ'}\right)$ = 784.09. Thus, the relative estimation error of the household’s total expenditures was not $cv\left(\hat{θ}\right)$ = 0.0091 but $RRMSE\left(\hat{θ}\right)$ = 0.1371.

It should be noted that the estimate of the bias value given here is rather high. This may be due both to the shortcomings of the calibration procedure, which is only being tested, and to the significant influence of under-coverage of the well-to-do strata of the population by the survey.

The effects of under-coverage of the well-to-do strata by surveys are being studied at the present time by specialists of SSSU and experts. The level of refusals in population and household surveys in Ukraine, as in other countries, is increasing, especially in large cities. At the same time, additional sources of data are appearing, particularly for official statistics data from registers are becoming more accessible, and their quality is generally improving.

In such circumstances, the possibility of using procedures to improve the reliability of survey results based on data from external sources is certainly attractive, especially if it remains possibility to work with a sufficiently complete set of microdata, rather than with individual variables.

In a microdata set users usually see and use only one variable of the sample weights and therefore a decrease in the bias of the estimates based on the calibration procedures for them can be quite imperceptible. At the same time, for specialists of statistical agencies, the amount of bias can show the extent of the problem of under-reaching of certain strata of the population, if any.

Of course, a serious problem remains the estimation of the indicator’s biases on base of two systems of weights – before and after calibration. With a large number of indicators and varying degrees of detailing, it is probably will be necessary to apply special procedures, for instance, smoothing or trimming, to avoid large mistakes.

 **4. References**

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