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### The Structure of Incomes Analysis in Slovak Republic and Regions of the Slovak Republic Based on EU-SILC Data

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**Abstract:** The paper deals with the structure of incomes analysis in the whole Slovak Republic and separately in eight Slovak regions based on the European Union statistics on income and living conditions in the Slovak Republic data. In the analysis, the data of the year 2014 are used. The population frequency distribution is estimated with the aid of sampling weights for the whole Slovak Republic and separately for eight Slovak Republic regions. Then the regional results are compared mutually as well as with the results for the whole Slovak Republic.

**Keywords:** Structure of Incomes, Sampling Weights, Population Frequency Distribution, Frequency Estimate

#### 1. INTRODUCTION

Household incomes, their level and structure significantly affect the behavior of microeconomic entities as owners of production factors, consumers, savers and consequently investors. Thus income structures also determine macroeconomic indicators such as consumption, savings and investment of household into physical and human capital.

The structure of incomes analysis in regions of the Slovak Republic will be effectuated on the basis of data from EU-SILC (the European Union Statistics on Income and Living Conditions) collected in the Slovak Republic in the year 2014. EU-SILC is an instrument aiming at collecting timely and comparable cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion, and living conditions. This instrument is anchored in the European Statistical System (for more details see: European Union Statistics on Income and Living Conditions (EU-SILC). Available at: <http://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions>).

The survey containing more components, such as random sampling, stratification, clustering and so on is obviously called complex survey. A survey may be stratified with several stages of clustering and rely

on ratio and regression estimation to adjust for other variables. In these cases sampling weights based on auxiliary information are commonly used to provide the correct results. EU-SILC data are the data from complex survey.

The structure of incomes analysis in regions of the Slovak Republic based on using sampling weights is studied in the paper. On the basis of sampling weights the population frequency distribution of the whole gross household incomes is estimated for the whole Slovak Republic as well as for eight domains – the regions of Slovakia.

## 2. REVIEW OF LITERATURE

There are a lot of papers concerning the incomes distribution estimation and structure analysis, studying these problems from different perspectives, for example in Kloek (1987) the estimation of income distribution parameters is studied. The parameters of several families of distributions are estimated by means of minimum  $\chi^2$ . The approach is applied on random samples taken from Dutch income-earning groups in 1973. In Gosh *et al.* (1996) a general methodology for small domain estimation based on the data collected in repeated surveys is studied. The results are directly applied to the estimation of median income of four-person families for all 50 states of the United States and the District of Columbia. In Sala-i-Martin (2006), the world distribution of income by integrating individual income distributions for 138 countries between 1970 and 2000 is presented. In Dowrick (2006) the global income inequality is studied. In Wang and Woo (2011) the size and distribution of hidden household income in China are analyzed. In Atkinson and Salverda (2005) a method for using income-tax data to investigate the evolution of the highest incomes over virtually the entire 20th century is developed. In Chotikapanich *et al.* (2007) the national and regional income distributions are estimated within a general framework that relaxes the assumption of constant income within groups. A technique to estimate the parameters of a beta-2 distribution using grouped data is proposed.

## 3. METHODS

Sometimes the standard statistical methods supposing the independence and identic distribution of observations are applied to the data from complex surveys. In Lohr (2010, pp. 287 – 288) is stated: "When you read the paper or book in which the authors analyze data from the complex survey, see whether they accounted for the data structure in the analysis, or whether they simply ran the raw data through non-survey statistical package procedure and reported the results. If the latter, their inferential results must be viewed with suspicion".

### 3.1. Sampling Weights

The sampling weights (design weights) allow to construct an empirical distribution for the population (in fact it is an empirical distribution of the observation from the population). On the basis of this distribution the estimation of some population quantities is possible.

Suppose the size  $N$  of finite population  $U$  is known. Symbol  $x$  denotes variable under study and also its values,  $U = \{1, 2, \dots, N\}$  is the set of unit indexes in the population. Symbol  $S$  denotes sample from the population – subset containing  $n$  units from  $U$ . Let's  $\pi_i$  be the probability that unit  $i \in U$  will be in random sample. Sampling weights for any sampling design are defined as follows

$$w_i = \frac{1}{\pi_i} \quad (1)$$

Sampling weight of unit  $i$  can be interpreted as number of units in the population represented by unit  $i$ . These weights can be modified with regard to nonresponse and coverage error (for more details see, for example, Levy and Lemeshow (2008)). Sampling weights for all observations units are equal in self-weighting surveys. Each observed unit represents the same number of unobserved units in the population. Sampling weights are not equal for all observations units in non-self-weighting surveys. If the sample is non-self-weighting, point estimates of population quantities produced by standard statistical software supposing statistical independence and the same distribution of observations, will be biased. It is also the case in the above mentioned application. The EU-SILC sample is non-self-weighting. The capturing the structure of data is necessary in point estimation of population quantities. The use of sampling weights is needed.

### **3.2. Frequency Distribution Estimation by Data from a Complex Survey**

Below the description how to use the sampling weights in population frequency distribution estimation is presented. If a sample is self-weighting, the frequencies calculated from sample data estimate the population frequency distribution. If a sample is non-self-weighting, the sampling weights are used to construct a frequency distribution that estimates the population frequency distribution. The range of the data is divided into  $k$  classes with each class having width  $b$ .

The frequency of class  $j$  estimate is

$$\hat{n}(j) = \sum_{i \in S} w_i u_i(j) \quad (2)$$

where  $u_i(j) = 1$  if observation  $i$  is in class  $j$  and 0 otherwise.

The relative frequency of class  $j$  estimate is

$$\hat{f}(j) = \frac{\hat{n}(j)}{\sum_{i \in S} w_i} \quad (3)$$

Note that estimators constructed using sampling weights are not necessarily unbiased or numerically stable. For example, the estimator of the population variance is sensitive to roundoff error. Despite of it the statistics calculated using weights are much closer to the population quantities than in not weighting case (Lohr, 2010, p. 293).

## **4. THE STRUCTURE OF INCOMES ANALYSIS IN SLOVAK REPUBLIC AND REGIONS OF THE SLOVAK REPUBLIC**

The structure of incomes analysis in the Slovak Republic regions was effectuated using the data from the survey EU-SILC executed in the Slovak Republic in 2014. In the Slovak Republic the stratified two-stage survey design was used. The stratification was effected with two stratification variables – region and settlement size. There are eight regions in the Slovak Republic: Bratislava, Trnava, Trenčín and Nitra in western Slovakia, Žilina and Banská Bystrica in central Slovakia, Košice and Prešov in eastern Slovakia. The EU-

SILC 2014 survey was executed on the sample of 6,010 households, 5,490 households and 13,433 individuals 16+ were included in the database. Sampling weights were calculated and modified with respect to nonresponse. These weights can be used to inference about the population of Slovak Republic households. EU-SILC sample data are the data from non-self-weighting survey.

The data from EU-SILC 2014 survey are concentrated in many sets. Each household is identified by one identification number. The structure of the whole gross household incomes in eight domains – the Slovak Republic regions –was analyzed. The above mentioned regions correspond with the categories of one from stratification variables. Firstly, the matching of needed data – sampling weights and whole gross household incomes was effected according to household numbers. Then, the matched data were distributed according to regions. Eight sets of data were obtained, one for each region. Each region was analyzed separately. The values of estimated frequencies and relative frequencies were calculated according to (2) and (3) for the whole Slovak Republic and separately for each Slovak Republic region. The number of Slovak households in 2014 can be estimated by the sum of sampling weights:  $\sum_{i \in S} w_i = 1,850,842$ . The widths of classes in frequency distribution is 10,000 euros.

In Table 1 frequency distribution of Slovak Republic households according to the whole gross household income in 2014 is estimated.

**Table 1**  
**Estimated frequency distribution of Slovak Republic households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	681,765	0.368353867	36.8353867
10 000-20 000	673,063	0.363652031	36.3652031
20 000-30 000	329,995	0.178294667	17.8294667
30 000-40 000	104,565	0.056495929	5.6495929
40 000-50 000	36,541	0.019742807	1.9742807
50 000-60 000	11,861	0.006408485	0.6408485
60 000-70 000	5,038	0.002721654	0.2721654
70 000-80 000	1,381	0.00074667	0.074667
80 000-90 000	1,647	0.000889726	0.0889726
90 000-100 000	1,791	0.000967691	0.0967691
100 000-	3,195	0.001726463	0.1726463
Sum	1,850,842	1	100

*Source:* own

Table 1 shows that the greatest proportion of households in the Slovak Republic has incomes less or equal to 10,000 euros, the households having incomes greater than 10,000 and less or equal to 20,000 euros are also frequent. The classes with incomes greater than 50,000 euros account for less than one percent.

Table 2 presents estimated frequency distribution of Bratislava region households according to the whole gross household income in 2014. The greatest proportion of households has incomes less or equal

to 10,000 euros also in Bratislava region, but in this region the percentages of classes with higher incomes – exceeding 50,000 euros, are greater than in the whole Slovakia. This is an expected result because Bratislava region includes the capital of the Slovak Republic.

**Table 2**  
**Estimated frequency distribution of Bratislava region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	79,525	0.323275	32.3275
10 000-20 000	78,676	0.319824	31.9824
20 000-30 000	49,859	0.202683	20.2683
30 000-40 000	21,455	0.087218	8.7218
40 000-50 000	8,118	0.033	3.3
50 000-60 000	2,297	0.009338	0.9338
60 000-70 000	1,665	0.006768	0.6768
70 000-80 000	858	0.003487	0.3487
80 000-90 000	1,499	0.006094	0.6094
90 000-100 000	1,053	0.004281	0.4281
100 000-	992	0.004032	0.4032
Sum	245,997	1	100

*Source: own*

Table 3 shows estimated frequency distribution of Trnava region households according to the whole gross household income in 2014.

**Table 3**  
**Estimated frequency distribution of Trnava region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	63,301	0.331387	33.1387
10 000-20 000	72,566	0.379891	37.9891
20 000-30 000	40,883	0.214028	21.4028
30 000-40 000	10,566	0.055313	5.5313
40 000-50 000	2,449	0.012819	1.2819
50 000-60 000	392	0.002054	0.2054
60 000-70 000	0	0	0
70 000-80 000	392	0.002053	0.2053
80 000-90 000	0	0	0
90 000-100 000	469	0.002455	0.2455
100 000-	0	0	0
Total	191,018	1	100

*Source: own*

The greatest proportion of households in Trnava region has incomes greater than 10,000 and less or equal to 20,000 euros. That is different when compared with the whole Slovak Republic and also with Bratislava region. There are also the classes accounting for zero percentage in this region.

Table 4 presents estimated frequency distribution of Trenčín region households according to the whole gross household income in 2014.

**Table 4**  
**Estimated frequency distribution of Trenčín region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	71,005	0.342054349	34.2054349
10 000-20 000	78,000	0.375751064	37.5751064
20 000-30 000	38,746	0.186650581	18.6650581
30 000-40 000	12,614	0.060763388	6.0763388
40 000-50 000	3,840	0.018497057	1.8497057
50 000-60 000	1,953	0.009409457	0.9409457
60 000-70 000	422	0.002030738	0.2030738
70 000-80 000	0	0	0
80 000-90 000	0	0	0
90 000-100 000	0	0	0
100 000-	1,005	0.004841083	0.4841083
Total	207,585	1	100

*Source: own*

The greatest proportion of households in Trenčín region has incomes greater as 10,000 and less or equal to 20,000 euros. The distribution is very similar to the distribution of Trnava region, only the nonzero proportion of the “richest” households, having incomes exceeding 100,000 euros is more significant.

Table 5 shows estimated frequency distribution of Nitra region households according to the whole gross household income in 2014.

**Table 5**  
**Estimated frequency distribution of Nitra region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	101,107	0.412978	41.2978
10 000-20 000	84,936	0.346926	34.6926
20 000-30 000	41,684	0.17026	17.026
30 000-40 000	10,876	0.044423	4.4423
40 000-50 000	4,281	0.017486	1.7486

*contd. table 5*

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
50 000-60 000	430	0.001758	0.1758
60 000-70 000	1,017	0.004153	0.4153
70 000-80 000	0	0	0
80 000-90 000	0	0	0
90 000-100 000	0	0	0
100 000-	494	0.002017	0.2017
Total	244,825	1	100

*Source:* own

The greatest proportion of households in Nitra region has incomes less or equal to 10,000 euros, i.e. the “poorest” households are the most frequent, but, on the other hand, there are also households having incomes greater than 100,000 euros.

Table 6 presents estimated frequency distribution of Zilina region households according to the whole gross household income in 2014.

**Table 6**  
**Estimated frequency distribution of Zilina region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	76,417	0.349275	34.9275
10 000-20 000	83,579	0.382008	38.2008
20 000-30 000	35,675	0.163056	16.3056
30 000-40 000	12,911	0.05901	5.901
40 000-50 000	6,257	0.028598	2.8598
50 000-60 000	2,151	0.009833	0.9833
60 000-70 000	1,666	0.007615	0.7615
70 000-80 000	132	0.000603	0.0603
80 000-90 000	0	0	0
90 000-100 000	0	0	0
100 000-	0	0	0
Total	218,788	1	100

*Source:* own

The greatest proportion of households in Zilina region has incomes greater than 10,000 and less or equal to 20,000 euros. There is zero proportion of households having incomes greater than 80,000 euros.

Table 7 presents estimated frequency distribution of Banska Bystrica region households according to the whole gross household income in 2014.

**Table 7**  
**Estimated frequency distribution of Banska Bystrica region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	100,138	0.41775	41.775
10 000-20 000	88,875	0.370765	37.0765
20 000-30 000	34,706	0.144786	14.4786
30 000-40 000	9,270	0.03867	3.867
40 000-50 000	4,927	0.020554	2.0554
50 000-60 000	1,079	0.0045	0.45
60 000-70 000	0	0	0
70 000-80 000	0	0	0
80 000-90 000	148	0.000616	0.0616
90 000-100 000	115	0.000481	0.0481
100 000-	450	0.001877	0.1877
Total	239,708	1	100

*Source:* own

The greatest proportion of households in the region Banska Bystrica has incomes less or equal to 10,000 euros. There is also non-zero proportion of households having incomes more than 80,000 euros.

Table 8 shows estimated frequency distribution of Presov region households according to the whole gross household income in 2014.

**Table 8**  
**Estimated frequency distribution of Presov region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	89,901	0.378602	37.8602
10 000-20 000	77,777	0.327543	32.7543
20 000-30 000	47,608	0.200495	20.0495
30 000-40 000	15,577	0.065599	6.5599
40 000-50 000	4,134	0.01741	1.741
50 000-60 000	1,781	0.007502	0.7502
60 000-70 000	268	0.001128	0.1128
70 000-80 000	0	0	0
80 000-90 000	0	0	0
90 000-100 000	154	0.000648	0.0648
100 000-	255	0.001073	0.1073
Total	237,454	1	100

*Source:* own

The greatest proportion of households in Presov region has incomes less or equal to 10,000 euros. There are no incomes in the classes 70 000 – 90 000. On the other hand, the proportion of households with “middle” incomes, for example, greater than 20,000 and less or equal to 30,000 euros accounts for about 20 %, in Banska Bystrica region only 14.48 %.

Table 9 presents estimated frequency distribution of Kosice region households according to the whole gross household income in 2014.

**Table 9**  
**Estimated frequency distribution of Kosice region households according to the whole gross household income in 2014**

<i>Income (euros)</i>	<i>Estimated frequency</i>	<i>Estimated relative frequency</i>	<i>Estimated percentage</i>
-10 000	100,371	0.378090553	37.8090553
10 000-20 000	108,653	0.409291744	40.9291744
20 000-30 000	40,833	0.153817146	15.3817146
30 000-40 000	11,298	0.04255712	4.255712
40 000-50 000	2,536	0.009551283	0.9551283
50 000-60 000	1,777	0.0066929	0.66929
60 000-70 000	0	0	0
70 000-80 000	0	0	0
80 000-90 000	0	0	0
90 000-100 000	0	0	0
100 000-	0	0	0
Total	265,468	1	100

*Source:* own

The greatest proportion of households in Kosice region has incomes greater than 10,000 and less or equal to 20,000 euros. There are no households having incomes exceeding 60,000 euros.

## 5. CONCLUSIONS

All calculations were executed using Excel 2013. The distribution of Slovak households according to the whole gross household income in 2014 is intriguing from the perspective of the whole Slovak Republic as well as its regions. The obtained information can be very useful in many areas, for example, in some marketing studies. The thousands of households having yearly incomes exceeding 60,000 euros (in all classes) can be found in Bratislava region. The presence of “richer households” differs in other regions. The incomes greater than 60,000 and less or equal to 70,000 euros refer to 1,665 households in Bratislava, 422 households in Trencin , 1,017 in Nitra , 1,666 in Zilina, and 268 in Presov regions. In the rest of regions no households of this class are represented. The incomes greater than 70,000 and less or equal to 80,000 euros can be found in 858 households in Bratislava, 392 households in Trnava and 132 households in Zilina regions. In the rest of regions no households of this class are represented. 1,499 households in Bratislava and 148 households in Banska Bystrica regions have the incomes greater than 80,000 and less or equal to 90,000 euros. The incomes greater than 90,000 and less or equal to 100,000 euros are identified in 1,053 households

in Bratislava, 469 households in Trnava, 115 households in Banska Bystrica, and 154 households in Presov regions. The incomes exceeding 100,000 euros are in 992 households in Bratislava, 1,005 households in Trencin, 494 households in Nitra, 450 households in Banska Bystrica, and 255 households in Presov regions.

The application of correct methodology of estimation is very important in the context of the data stemming from complex surveys analyses. It is clear that the estimates acquired with the help of sampling weights that allow the used sample design, nonresponse and potentially also coverage error better reflect the reality.

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