ESTIMATE OF SCALE OF CONSUMPTION UNITS IN THE CZECH REPUBLIC BASED ON EXPENDITURES OF CZECH HOUSEHOLDS

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Abstract

The income level of each person depends on the size and character of her household. The aim of this paper is to estimate appropriate weights for members of households which should be considered as consumption units for evaluation of the income situation of people in the Czech Republic. The system of these weights is called 'scale of consumption units'. As each additional person realizes economies of scale, the indicator average income per consumption unit provides a better explanation than income per capita. Consumption units for the Czech households are estimated by quantification of household expenditures by using data from household budget surveys. Regression analysis is employed to analyze the relationship between household expenditures and the characteristics of households. As expected, economies of scale of Czech household members are more moderate than is considered in the international consumption units currently defined by the OECD and Eurostat which do not take national specifics into account. An application of the obtained consumption units on the income of Czech households assures a more accurate comparability of results by assessment of the income levels of people in the Czech Republic.

Key words: consumption units, equivalence scale, economies of scale, household disposable income.

1. Introduction

The estimation of scales of consumption units (so-called equivalence scale) is long-term challenge, which has not yet been sufficiently resolved. It is necessary to take into consideration the household size and structure because they mainly affect the level of income and consumption. An additional person in the household requires less resources to ensure the same standard of living than is required for the first person in the household (Gravelle and Ress, 2004). The range of economies of scale, which realize the household with multiple members, is unfortunately not obvious and clear. Nevertheless, the impacts of consideration these economies of scales on income or consumption indicators are very significant. Important effects are mentioned by Lapáček (2013) who observed differences between individual consumption unit's scales.

Jílek and Moravová (2007) define a consumption unit as follows: "The scale of consumption units for household members is defined as the values of relative volumes of consumption of various household members with the basis of the consumption of the

selected type of household member." It means that the first household member (usually an adult) is always considered as a base of this scale with the weight (or consumption unit) equal to one. The one person's household is regarded as the base (with the weight equal of one) for other household types with more members.

Many consumption unit scales were prepared especially for international comparison. Some of them are published by Chanfreau and Burchardt (2008). The most important scales are the Square root designed by Luxemburg Income Study (LIS), and the Oxford scale originally recommended by OECD. The second one takes into account the different needs between household members in dependence on demographic characteristics of people. Currently, the most used scale is the modified OECD scale prepared by Hagenaars et al. (1994), which is derived from the Oxford scale and also primarily applied by Eurostat. These scales were designed by experts of European or other international institutions in order to prepare approach that can be applied in all countries. It should ensure comparability of data on standard of living among countries.

Next to these approaches, other methods taking into account specific conditions could be used on national level. Buhmann et al. (1988) present the general approach based on survey data of consumption expenditures. They recommended preparing of scales by regression analysis of survey data is order to specify the relation between household size and total expenditures. The larger is the equivalence elasticity e, which varies between 0 and 1, the smaller elasticity the bigger economies of scale are assumed by the equivalence scale. The relation between expenditures and size could be expressed by some equation (Buhmann et al., 1988).

The other variables, than the household size, should be considered by finding the equation of household expenditures. The most important of them are presented in the following chapter and considered in this analysis. According to Van der Gaag and Smolensky (1982), it is necessary to distinguish between household with and without children. It is assumed that the impact on families with children by considering economies of scales is higher than on household of adults. The equivalence scale should reflect both economies of size and differences in household characteristics. Given household size, elasticity will decrease with the number of children (Schwarze, 2003). According to Dudel (2015) the estimates of nonparametric bounds on equivalence scales for couples with one child and childless couples as reference are between (1.16, 1.46). It means that the consumption unit for the child should be within interval from 0.16 to 0.46. The affected indicators by the assessment of equivalence scale are all income indicators based on personal income level, all income inequality indicators and finally also poverty rates indicators (Förster, 1994).

The aim of the paper is to estimate equivalence scale of consumption units appropriate for the conditions of households in the Czech Republic. They are based on expenditures of Czech households as they have not been calculated yet. The reason is that current equivalence scales used by Eurostat or OECD may not be appropriate for Czech households. The rest of the paper is organized as follows. Firstly, we present data and methods used for our estimates, then we give the results of our analysis and finally we assess consequent impacts of our estimates. In conclusion the comparison to international equivalence scales is carried out and possible differences and impacts are discussed.

2. Data and Methodology

The data used for assessment of economies of scale by each household are taken from the Household Budget Survey (HBS), which collects information about household

expenditures[1]. This survey is conducted by Czech Statistical Office every year with the sample size of around 3000 households. It provides data on expenditures and consumption structure of private households. The aim of the survey is to produce statistics on consumption, expenditures and income of all members of household, data on household structure, the equipment of dwelling and other economic characteristics of household. Data are collected monthly, however results are published annually. For estimation of equation of household expenditures the most important household characteristic should be defined. In OECD guidelines Recommendations for choice of variables can be found in OECD guidelines.

The experts (Buhmann et al., 1988) defined crucial household characteristics that mostly influence their consumption and their structure of expenditures. Number of household members taking into account number of children is the main factor. The explanatory variables in regression analysis are the number of adults and the number of children meaning up to 14 years. This age boundary was chosen according to recommendation of OECD experts preparing of consumption unit's scales (Chanfreau and Burchardt, 2008). Household budget survey in the Czech Republic provides data that enables to estimate consumption unit based on expenditures of households and their characteristics.

According to van der Gaag and Smolensky (1982) the expenditures of households should be modeled by some equation. The simplified version of equation of expenditures is as follows:

$$q_i = a_0 + a_i, \tag{1}$$

where q_i is the total expenditures amount for household i, a_0 is the expenditures of one person's household (base), a_i are the specific differences of expenditures for household type i (households with specific demographic structure i) in relation to one-person's household. The next step is to quantify the system of weights for each specific household type i by using the parameter d_i, which could be derived from equation (1) as follows:

$$d_i = a_i/a_o. \tag{2}$$

After that it is possible to assign to each specific household i the number of consumption units m_i according to formula (van der Gaag and Smolensky, 1982):

$$m_i = 1+d_i. \tag{3}$$

The first equation could be estimated using regression analysis. The type of regression function should correspond with real course of function of total expenditures that could be estimated by data exploring. In household budget survey there is variable "household size" that is considered as quantitative because the number of months spent in specific household is taken into account. Because of this, the method of linear regression could be used by all significant input variables, as it is treated for example in analysis by Bishop (2015). The regression coefficients mean the expenditures increase by addition of further observations (the additional household member in our case).

3. Results

### 3.1 Equation of Households Expenditures

The household expenditures could be described by equation (1), which takes into account the type of household. The shape of regression function should be defined at first. The results

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[1] Available at https://www.czso.cz/csu/czso/statistika-rodinnych-uctu-metodika (accessed in April 2016).

of data exploring can be helpful for recognizing of some dependence. The explanatory variable for this analysis was just the household size, because this factor affects the level of expenditures at the most. The simple dependence of total expenditures by household size, which is indicated as quantitative, was provided.

The results could be observed in Figure 1, where the shape of total household expenditures distribution by household size is shown. The total expenditures increase caused by higher household size up to five-member household, in which the total amount is even lower than four-member household. Based on these results, the shape of function of dependence seems be more likely parabolic than linear. The peak of this function seems to be between 4 and 5, it means that the break in expenditures increase lies close behind the fourth member in one household. In addition, it is necessary to distinguish between adults and children because children have the different impact on expenditures than adults. The square of number is used just for adults in household, not for children. The number of children up to 14 years is considered as other separate variable in the regression analysis.

Figure 1: The dependence of total household expenditures by household size
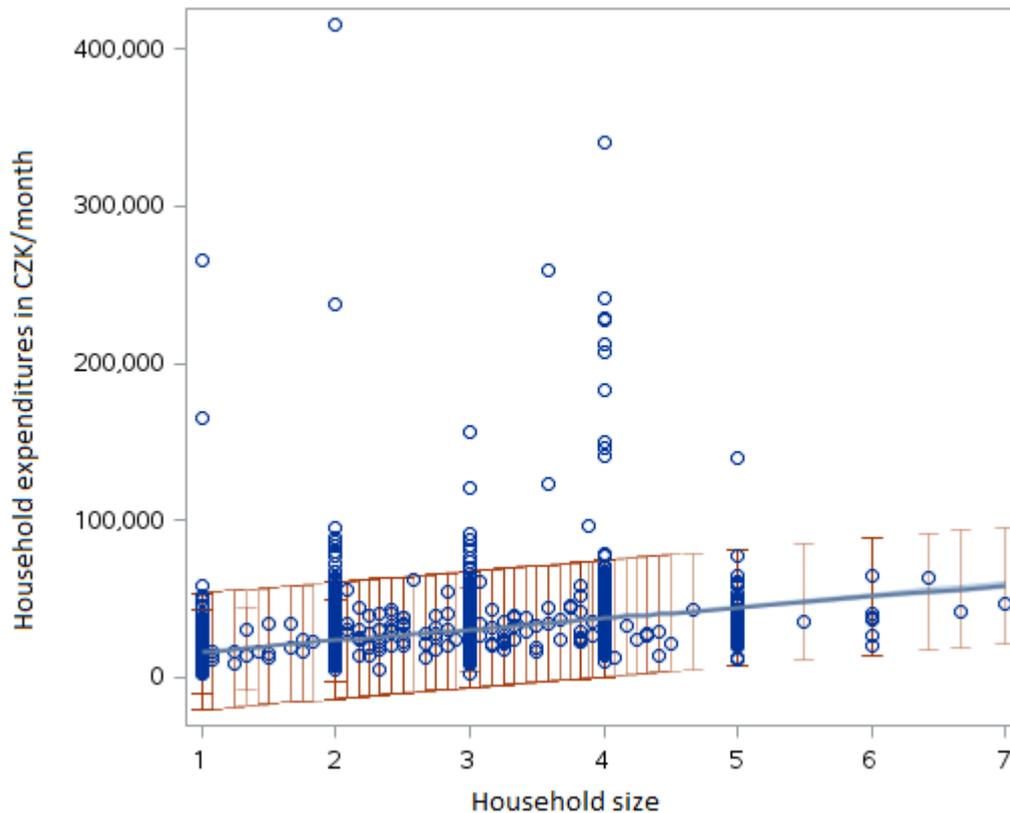
Source: the authors.

The following formula, extended from the general (1) is used:

$$q_i = b_0 + b_1 \times adult_i + b_2 \times adult_i{}^2 + b_3 \times children_i \, , \tag{4}$$

where q_i stands for expenditures in household i, $adult_i$ for the number of adult members and $children_i$ for the number of children in household i. Regression coefficients are the specific amount of expenditures added for each variable.

In this case the base of the equivalence scale of consumption units, precisely the one-person's household, could be expressed as following:

$$a_0 = b_0 + b_1 + b_2. \tag{5}$$

The parameter d_i that allows us to find the system of weights of additional household members for each specific household type i with the number of adults ($adult_i$) and the number of children ($children_i$) can be derived from following formula:

$$d_i = ((b_0 + b_1 \times adult_i + b_2 \times adult_i^2 + b_3 \times children_i) - (b_0 + b_1 + b_2)) / (b_0 + b_1 + b_2). \tag{6}$$

3.2 Results of Regression Analysis by Using the Equation of Household Expenditures

According to equation (4) determined in the previous chapter, the regression analysis could be provided. The result is given in the following table (Table 1). This whole regression model has Adjusted R-square value equal to 0.184, it can explore just 18.4 % of total variability of expenditures. Nevertheless, it is not the aim of this paper. All parameter estimates are significant for this analysis because their p-value is close to 0, except for the intercept, which is negligible. However, multicollinearity is observed in the model. It is probably caused by the inclusion on power of variable adult. The goal for the future is to redesign the model to avoid multicollinearity. The estimates are given in CZK per month.

Table 1: Parameter estimates of regression analysis

Variable	Parameter estimate	Standard error	T value	Pr > |t|	Standardized estimate	Variance inflation
Intercept	-272.6	1680.3	-0.16	0.8711	0.000	0.000
adult	16771.0	1614.1	10.39	<.0001	0.706	16.347
adult^2	-1898.4	341.6	-5.56	<.0001	-0.375	16.141
children	5029.7	4814	10.45	<.0001	0.182	1.075

Source: the authors.

The result equation of household expenditures from the regression analysis based on survey data from year 2014 is as follows:

$$\hat{q}_i = -273 + 16771 \times adult_i - 1898 \times adult_i^2 + 5030 \times children_i. \tag{7}$$

3.3 Estimates of Consumption Units

The parameters of result equation allow us to compute total expenditures for each specific type of household taking into account the household structure. In Table 2 there are the total numbers of consumption units in each specific household type and also the estimates of consumption units, which belong to further additional member of household based on increase of expenditures that he or she brings relative to one-person's household. The second adult in household causes the increase of total expenditures in year 2014 by about 76 %, for third and following adult it is much less. The first child leads to increase in total expenditures just about of 34 %. Children's demand is not so large as it is for adults. The total

expenditures of multi-household with children show higher economies of scale than multi-households of adults.

These results should be proved on other survey sample by using data from previous years. Such a regression analysis was carried out with similar values of parameter estimates and similar result equations. The most important results are shown in Table 3. There are estimates of means of total expenditures by particular type of household and the weights of the second additional member of household by taking into account the difference between adults and children. The weights for adults seem the same for every years, namely on value of 0.76. On the other hand, the weights for children vary between 0.21 and 0.42, the average of these five year is on level of 0.31.

Table 2: Estimates of total expenditures (in CZK per month) and system of consumption units by household structure in the year 2014

Household structure	Total expenditures	Number of consumption units	Consumption unit of additional adult
1 adult	14 600	1.00	-
2 adults	25 676	1.76	0.76
3 adults	32 955	2.26	0.50
4 adults	36 438	2.50	0.24
1 adult with child	19 630	1.34	0.34
1 adult + 2 children	24 659	1.69	0.34
2 adults with child	30 706	2.10	0.34
2 adults + 2 children	35 735	2.45	0.34

Source: the authors.

Table 3: Estimates of total expenditures and consumption units of further members of household in each year

	1 adult	2 adults	Consumption unit of further adult	1 adult with child	Consumption unit of further child
2014	14 600	25 676	0.76	19 630	0.34
2013	14 781	25 950	0.76	18 188	0.23
2012	14 272	25 108	0.76	20 294	0.42
2011	14 631	25 740	0.76	17 710	0.21
2010	14 104	24 506	0.74	19 022	0.35

Source: the authors.

According to this analysis the consumption units are stable during the time and the average results could be considered as the weights of further household members. For additional adults in household, it means weight of 0.75 and for additional child up to 14 years it results on level of 0.3. These units are combination between two most frequent used scales, the OECD scale (1; 0.7; 0.5) and the modified OECD scale (1; 0.5; 0.3), which is used by Eurostat for income indicators measurement in each EU country[2]. According to results of our research, appropriate consumption unit's scale is (1; 0.75; 0.3) for the Czech Republic. The further adult in household realizes in Czech Republic lower economies of scale than the

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[2] Available at http://www.oecd.org/eco/growth/OECD-Note-EquivalenceScales.pdf (accessed in April 2016).

European average. Otherwise the consumption level of child (up to 14 years) means just 0.3 of total consumption of one-person's household. The economies of scale are higher for the household with children than for household (with the same household size) of adults.

3.4 Impact of Consumption Units on Income Indicators

The scale of consumption units is the important factor affecting the indicators comparing the conditions of households. The assessment of consumption units impacts primarily the income indicators. Considering the consumption units instead of members in household it increases the average personal income, the income per consumption unit (equivalised income) will be higher than income per capita. The equivalence scale changes distribution of income and thereby the income inequality and all of indicators dependent on income, especially the poverty line and at risk of poverty rate. According to (de Vos and Zaidi, 1997) the poverty line is very sensitive on equivalence scale, because it depends on number of consumption units which dispose with the total household income.

4. Conclusion

The definition of consumption unit's scale has a huge impact on evaluation of economic and social conditions of households. Currently, international equivalence scale is applied. There is the advantage of common methodology and results should be comparable. People may also believe that equivalence scale does not differ significantly as societies are similar even in Europe. However, it has been proved that equivalence scale in the Czech Republic is not the same as equivalence scale used by Eurostat or OECD.

The OECD scale with weights (1; 0.7; 0.5) is applied by OECD for international comparison of countries across the world. The modified OECD scale with more restricted weights (1; 0.5; 0.3) is commonly used by Eurostat for comparisons among European countries. Nevertheless, analysis of households in each country should be based on the national consumption unit's scale.

The estimated consumption unit's scale for the Czech Republic is as follows: (1; 0.75; 0.3) based on our research. An additional person in household requires 75% resources in comparison to the first household member. The economies of scale are just 25% for the household of two members. The consumption level of child in household represents just 30% of value of first adults in a household so the weight of the child is 0.3. The range of economies of scale for children is similar to modified OECD scale.

Use of this estimated equivalence scale for Czech households leads to more appropriate assessment of their economic and income conditions. In comparison to modified OECD scale the estimated consumption unit's scale decreases the equivalised income for household with more adults because it takes into account smaller economies of scale. Total household income is distributed between more consumption units.

It was proved that households realize not so huge economies of scales in the Czech Republic as it is assumed in international scales. The consumption of Czech households depends on household characteristic such as household structure namely the size and number of children is taken into account. However, other characteristics are not taken into account. Currently, limited characteristics of households are available in household budget survey. The survey is now being redesigned and it will be merged with EU-SILC. More information about particular households will be available in the future. The challenge for further research consists in design of more complex model including more variables.

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References

[1] BISHOP, J. A. et al. 2015. Subjective poverty equivalence scales for euro zone countries. In Journal of Economic Inequality, 2014, vol. 12, iss. 2, pp. 265-278.

[2] BUHMANN, B. et al. 1988. Equivalence scales, well-being, inequality, and poverty – sensitivity estimates across 10 countries using the Luxembourg income study (Lis) database. In Review of Income and Wealth, iss. 2, pp. 115-142.

[3] DE VOS, K., ZAIDI, M. A. 1997. Equivalence scale sensitivity of poverty statistics for the member states of the European Community. In Review of Income and Wealth, iss. 3, pp. 319-333.

[4] DUDEL, C . 2015. Nonparametric bounds on equivalence scales. In Economics Bulletin, 2015, vol. 35, iss. 4, pp. 2161-2165.

[5] FÖRSTER, M. F. 1994. Measurement of low incomes and poverty in a perspective of international comparisons. In Labour market and social policy, OECD, Directorate for education, employment, labour and social affairs, no. 14, 1994. http://www.oecd-ilibrary.org/docserver/download/5lgsjhvj7v5g.pdf?expires=1460379899&id=id&accnam e=guest&checksum=8D171B0609737C927D1CEF2570D19C18.

[6] GRAVELLE, H., RESS, R. 2004. Microeconomics. 3rd ed. New York : Pearson Education, 2014.

[7] HAGENAARS, A., DE VOS, K., ZAIDI, M. 1994. Poverty statistics in the late 1980s: research based on micro-data. Luxembourg : Office for Official Publications of the European Communities, OECD, 1994.

[8] CHANFREAU, J., BURCHARDT, T. 2008. Equivalence scales: rationales, uses and assumptions. Edinburgh : Scottish Government, 2008.

[9] JÍLEK, J., MORAVOVÁ, J. 2007. Ekonomické a sociální indikátory. Praha : VŠE Praha, 2007.

[10] LAPÁČEK, M. 2013. Ekvivalenční stupnice a příjmová nerovnost [online], Praha, 2013 [cit. 2016-03-30] http://nf.vse.cz/download/veda/workshops/inequality.pdf.

[11] SCHWARZE, J. 2003. Using panel data on income satisfaction to estimate equivalence scale elasticity. In Review of Income And Wealth, 2003, iss. 3, pp. 359-372.

[12] VAN DER GAAG, J., SMOLENSKY, E. 1982. True household equivalence scales and characteristics of the poor in the United satets. In Review of Income and Wealth, 1982, vol. 28, iss. 1, pp. 17-28.