

## ANALYSIS OF ECONOMIES OF SCALE IN CZECH HOUSEHOLDS BASED ON DIFFERENT APPROACHES

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### Abstract

*The economic situation of households could be evaluated using different approaches. Nevertheless, all methods have to deal with the same fact: economies of scale. The household structure meaning the size and other demographic and economic characteristics of household members should be always taken into account. Economies of scale are represented by the equivalence scale of consumption units. The current international consumption unit scale may not be appropriate as economies of scales might differ among countries. Therefore, the national scale should be estimated. Economies of scale of Czech households and subsequently consumption unit scales are analysed from more perspectives in the paper. An alternative approach to consumption unit scales applied in other countries is based on household expenditures. We have estimated the consumption unit scale within our previous research. Another method that uses utility function is applied in this paper and compared to the previous one. This utility function of households is indirectly measured using subjective data of financial satisfaction. The analysis is based on data from EU\_SILC. Consumption units are estimated applying regression. At first the estimation of economies of scale based on expenditures and utility function are provided. Subsequently, the results of estimated consumption unit's scale are compared also with international scales. Finally, all approaches are compared and the impact on indicators of income or consumption is assessed.*

**Key words:** *economies of scale, consumption units, equivalence scale, household expenditures, utility function*

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### 1. Introduction

The evaluation of income situation among households is affected by determination of economies of scale realized by Czech households. The income indicators are influenced by used scale of consumption units (CU). Some of the expert consumption unit's scales were harmonized for international comparison. For assessment across European countries the modified OECD scale is commonly used by Eurostat. This considers the same economies of scale for all European countries on level of 0.5 for an additional adult in household and 0.3 for a child. The system of weights (1; 0.5; 0.3) is called equivalence scale. Despite many advantages of this methodologically harmonized concept, the estimation of national scales is highly recommended by many experts. The national equivalence scale could more precisely

reflect the national economic and social conditions according to real extent of economies of scale realized by Czech households. A lot of other general approaches how to estimate the national economies of scale have been introduced. Some of them are computed on survey data about consumption, expenditures or income satisfaction.

The aim of this paper is to estimate the extent of national economies of scale according to different approaches and to compare the estimated equivalence scales appropriate for the conditions of households in the Czech Republic. This analysis is primarily focused on the “utility” approach based on utility functions, which employs subjective financial satisfaction as a proxy for indirect utility functions. Individual financial satisfaction was surveyed within ad hoc module in 2013. Furthermore, the results are compared with the “expenditure” approach using the HBS data that involves smaller sample of households than EU-SILC. This demand approach utilises expenditures of various household types. Finally, both estimations of equivalence scale are assessed by relation to commonly used expert scale.

The impact of economies of scale is obvious primarily by comparison of living conditions of different household types. All of the income indicators, including the at-risk-of-poverty rate, are influenced by extent of economies of scale. Especially the structure of people below the poverty threshold is highly depended on the equivalence scale. Therefore, the impact of consumption unit’s scale on at-risk-of poverty rate across different household types is provided. In conclusion, some findings and recommendations are introduced.

The literature provides a variety of approaches to the measurement of economies of scale. The overview of the important methods is introduced by Buhmann et al. (1988). In this article two directions of way of estimating are presented. First one is the expert approach producing the expert scales and the second general approach is based on survey data resulting in survey based scales.

Among the expert scales there are counted especially the scales that are used for the purpose of international comparison. Some of them are published by Chanfreau and Burchardt (2008). In this group is included the Square root designed by Luxemburg Income Study (LIS) and the important ones OECD and OECD-modified equivalence scales. The first one is Oxford scale originally recommended by OECD and the second one is derived from this. This scale was prepared by Hagenaaers, De Vos and Zaidi (1994) and in this time this is commonly used by Eurostat. There is the advantage of considering the different needs among household members in relation to demographic characteristics of people. These expert scales were designed by experts of European or other international institutions in order to apply the common approach in all countries. It may ensure comparability of data on standard of living among countries.

Next to this approach, other methods taking into account the country specific needs could be used on national level. Buhmann et al. (1988) presents the general approach based on survey data on consumption expenditures. The recommendation for preparing of scales by regression analysis of survey data is to specify the power relation between household size and total expenditure. The larger is the equivalence elasticity  $e$ , which varies between 0 and 1, the smaller are the economies of scale assumed by the equivalence scale. The relation between needs and size could be expressed by some equation. Other authors recommend also considering of other variables within the equation of household expenditures.

According to Van der Gaag and Smolensky (1982) it is necessary to distinguish between household with and without children. The impacts of economies of scales should be higher on families with children than on household of adults. The equivalence scale should reflect both economies of scale 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 in the interval (1.16; 1.46), so the consumption unit for the child should be within interval from 0.16 to 0.46.

All these methods using the survey data could be according to Buhmann et al. (1988) categorized into two alternative approaches. It is possible to find the economies either from consumption level of households using data about their expenditures or from subjective perception of consumption level of household members.

This first “expenditure” approach is based on the method of linear regression using the equation for expenditures. The most important equations are presented by Van der Gaag and Smolensky (1982). The linear regression could be used including 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 household member.

A lot of other approaches, which are based on the second approach about subjective perception of consumption level, were introduced. In the article from Bütikofer and Gerfin (2009) the „utility“ approach is presented. This method based on utility functions employs subjective financial satisfaction as a proxy for indirect utility functions. In a simplified way, the methodology assumes that the economies of scale of people living together are realized when the sum of individual utilities from personal consumption of all household members exceeds the total household income. The data allows us to compare utility functions (expressed by financial satisfaction) of singles and people living in a couple and consequently to determine the economies of scale from living together.

The consumption unit’s scale is the important factor affecting the indicators comparing the living conditions of households. The assessment of consumption units impacts primarily the income indicators. Considering the consumption units instead of members in household increases the average personal income, the income per consumption unit (equivalised income) will be higher than income per capita. The impact of applying consumption units instead of number of members in household on income distribution is discussed by Malá (2015). The equivalence scale changes distribution of income and thereby the income inequality and all of indicators dependent on income, especially the poverty threshold and at-risk-of-poverty rate (Förster, 1994). According to De Vos and Zaidi (1997) the poverty threshold is very sensitive on equivalence scale, because it depends on number of consumption units which dispose with the total household income.

## **2. Data and Methodology**

### **2.1 Data**

For estimation of economies of scale using the expenditure approach the data from the Household Budget Survey (HBS) could be used and for the utility approach the data from the Survey on Income and Living conditions (EU-SILC) is necessary to use. Both of surveys are yearly conducted by the Czech Statistical Office and in this article the database for year 2013 is used because of module questions in SILC 2013 and the comparability of results. The first survey collects information about household expenditures (CZSO\_HBS, 2013) and the second one is focused on income and economic and financial situation of households (CZSO\_SILC, 2013). The comparison of estimated economies of scale according to both approaches could be done also by assessment of impact of estimated consumption unit’s scales on income indicators. The data about income for computing the income distribution, income indicators and at-risk-of-poverty rate come from EU-SILC.

## 2.2 Methodology

The expenditure approach has been already introduced in previous research by Brázdilová and Musil (2016). It was proved, that the household expenditures depend on number of adults and number of children in household. The final equation and estimated economies of scale as well as the equivalence scale according to expenditure approach was found.

Traditionally, an equivalence scale is defined as the ratio of the expenditures (or income) of two different household types with the same standard of living. Formally, this corresponds to the ratio of the cost functions of two household types evaluated at the same utility level. This requires comparability of the utility levels of different households.

Such an utility approach with methodology to indirect utility function is used by Bütikofer and Gerfin (2009). They specified a collective household model which attempts to capture both returns to scale in household consumption and unequal allocation of resources within the household. In this paper only the first step is applicated by considering of equal sharing of resources. The collective household models are based on individual preferences that are aggregated into household utility according to some rule. At first the individual preferences have to be specified.

Indirect utility function of person  $i$  has the form:

$$V_i = \alpha(z_i) + \beta \ln x_i + \varepsilon_i, \quad (1)$$

where  $V_i$  is utility,  $z_i$  are observable characteristics,  $x_i$  total consumption expenditure of person  $i$ . Single individuals are assumed to consume their income in each period, i.e.  $x = y^h$ , where  $y^h$  denotes household income. The indirect utility function for single households is as follows:

$$V = \alpha(z) + \beta \ln y^h + \varepsilon. \quad (2)$$

For couples the equation is more complex because it depends on sharing rule of consumption in couple. Returns to scale of living together exist if total private consumption of both household members  $f$  and  $m$  exceeds household income  $y^h$ . This effect is captured in the following formula:

$$x_m + x_f = \tau y^h. \quad (3)$$

The scalar  $\tau$  represents a household consumption technology that transforms household income  $y^h$  into total household consumption. It is called an overall returns to scale factor. If  $\tau = 1$  there are no returns to scale (all consumption is private). The logical upper bound for  $\tau$  is 2 (all consumption is public).

There is the sharing rule that determines which share of  $\tau y^h$  is allocated to the one member of the couple. If there is restriction about equal sharing of consumption in couples, then the consumption of one member is:

$$x = \frac{\tau y^h}{2} \quad (4)$$

Then the utility function of each member of couples is as follows:

$$V = \alpha(z) + \beta \ln \frac{\tau y^h}{2} + \varepsilon. \quad (5)$$

In this approach the half of returns to scale factor  $\frac{\tau}{2}$  identifies the equivalence scale under restriction of equal sharing of consumption. It measures the proportion of the household income of a couple, which a single needs to be as well off. It could be estimated regressing utility (as measured by income satisfaction) on log income and a dummy for living in a couple.

The traditional equivalence scale could be estimated using the general model of utility functions for each household type  $h$ :

$$V^h = \alpha(z) + \beta \ln x^h + \delta C, \quad (6)$$

where  $C$  is a dummy equal to one for couples, and  $\delta$  is the utility effect of being a couple. According to Bütikofer and Gerfin (2009) this expression reduces to individual utility for single households given in equation (1).

The resulting log equivalence scale if we take the couple as the reference household has the form:

$$\ln x^s - \ln x^c = \frac{\delta}{\beta}, \quad (7)$$

where  $x^c$  denotes expenditures of the couple household and  $x^s$  are expenditures of the single household. The share  $\delta / \beta$  is called the shift parameter.

Furthermore, the estimation of traditional equivalence scale parameter  $\frac{\tau}{2}$  is simply  $\exp(\delta / \beta)$ . It represents the proportion of the expenditures (or income) of a couple household a single household needs to be as well off, because it presents the share of  $x^s / x^c$ :

$$\frac{x^s}{x^c} = \frac{\tau}{2} = e^{\frac{\delta}{\beta}}. \quad (8)$$

The household of single is considered the reference household when consumption units of couples are estimated. The share of  $x^c / x^s$  could be estimated as  $1 / \exp(\delta / \beta)$ . It represents multiples that a household of couple has to spend in order to attain the same level of standard of living. Values are within the interval  $<1; 2>$ , where 1 means that the returns to scale are maximized and 2 represents no returns to scale of living together. It expresses the number of consumption units in the household of couple. As the results express number of consumption units for couple and weight of the first adult is 1 the weight of the second person in a household of couple is estimated as the difference. Developed methodology is used for computing of economies of scale and equivalence scale according to utility approach in this paper.

### 3. Results

#### 3.1 Results of Estimated Equivalence Scale According to Utility Approach

The regression analysis of utility with explained variable “the financial satisfaction of person” was carried out using explanatory variables logarithm of income, dummy indicators for being a couple and for presence of child in household, age and dummy indicator for level of education. This analysis was conducted using the data from EU-SILC 2013. The results of regression analysis based on indirect utility function are provided in following table.

The results of regression (parameters  $\beta$  and  $\delta$ ) are used to estimate consumption units. Shift parameter is computed as the share of  $\delta$  and  $\beta$ . The equivalence scale parameter is estimated

in order to obtain number of consumption units that are presented in the Table 1. Finally, weight of additional adult or child is computed and rounded to one decimal.

According to the results of estimation of economies of scale based on utility function the second adult in household has the weight 0.4 and the child in household has the lower weight on the level of 0.3. The additional adult represents 40% of consumption level of the first adult in household and the child represents 30% of consumption level of the first adult in household.

Table 1: Results of regression analysis based on utility function

	<b>Parameter Estimate</b>	<b>Standard Error</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
Intercept	-19.264	0.87043	-22.13	<.0001
$\beta = \ln(\text{income})$	1.96518	0.07067	27.81	<.0001
$\delta$ (couple)	-0.62348	0.07123	-8.75	<.0001
$\delta$ (child)	-0.46309	0.08831	-5.24	<.0001
Age	0.01732	0.00184	9.41	<.0001
Secondary	0.28939	0.07862	3.68	0.0002
Tertiary	0.75806	0.10736	7.06	<.0001

Source: The Authors

Table 2: Estimated parameters of number of consumption units (CU) based on utility function

	<b>Couple</b>	<b>Child</b>
Shift parameter = $\delta/\beta$	-0.317	-0.236
Equivalence scale parameter = $\exp(\delta/\beta)$	0.728	0.790
Number of CU = $1/\exp(\delta/\beta)$	1.373	1.266
Weight = $1/\exp(\delta/\beta) - 1$	0.4	0.3

Source: The Authors

Consumption unit's scales based on different approaches are compared in the table 3. Scales differ significantly. Per capita approach is nevermore used as it does not assume any economies of scale though they actually exist. Very similar results are observed for child. Except the OECD approach, all scales expect that consumption of child is about 30% of consumption level of the first adult in household. However, consumption level of the second and further adult varies. The lowest economies of scales (25%) are assumed in the expenditure approach. In contrast, the highest (60%) are expected within utility approach.

Table 3: Comparison of consumption unit's scales

<b>CU scale</b>	<b>First adult</b>	<b>Further adult</b>	<b>Further child</b>
per capita	1	1.00	1.00
OECD	1	0.70	0.50
modified OECD	1	0.50	0.30
estimated CU_expenditure	1	0.75	0.30
estimated CU_utility	1	0.40	0.30

Source: The Authors

### 3.2 Impact of Determination of Equivalence Scale on Income Indicators

The equivalence scale affects the income distribution, income indicators and poverty threshold for computing at-risk-of poverty rate. It is obvious that the choice of consumption unit's scales has an impact on poverty indicators. The poverty threshold is defined as the 60 % of median national equivalised disposable income. The data about income of households are provided by the Czech Statistical Office, which conducts the national version of international harmonized survey EU-SILC about living conditions of households. Finally, also the at-risk-of-poverty rate is influenced by equivalence scale because it expresses the share of people under the above mentioned poverty threshold. The impact of different consumption unit's scales on poverty indicators will be subject to our future research. We will focus not only on overall at-risk-of poverty rate but also on indicators by social groups of households. As composition of households may differ in each social group, the impact on each social group may be dissimilar.

### 4. Conclusion

The results of the analysis indicate that the national economies of scale differ from those that are taken into account by international harmonized expert scales. An additional member of Czech household, especially an adult, represents different weight than it is assumed by the OECD-modified equivalence scale. However, approaches lead to the different scales. According to „expenditure“ approach computed on expenditures of households the weight of additional adults is on level of 75% of the first household member. While the „utility“ approach based on subjective perception of financial satisfaction shows the weight lower, it is just around 40%. The consumption level of child in household stays on the same level as international modified OECD scale of 30%. Analysis of the causes of the differences will be subject to our future research. Nevertheless, it is obvious that international consumption unit's scales differ to scales estimated using data on Czech households.

This paper offers various ways to estimate the national economies of scale more appropriate for Czech conditions and establish a national equivalence scale. Both alternative approaches are compared in relation to commonly used expert scale. The “utility” approach has the unique opportunity to employ internationally harmonized data from EU-SILC, therefore the international comparison could be provided in further analysis. Consumption unit's scales have an impact on equalized income and subsequently poverty indicators can be affected. We will focus on it especially we will examine impacts of different social groups of households.

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