RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS
No. 73 2009
Quality of Life Improvement through Social Cohesion

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THE DEMOGRAPHIC CHARACTERISTICS AND ECONOMIC STATUS OF FAMILIES IN POLAND. METHODS AND EMPIRICAL RESULTS

Abstract

The main goal of this paper is to present the results of the empirical research aiming at deciding which variables actually do describe the demographic profile of families for which the estimated Engel's curve matches the empirical data best. The decision which variables to use in this work was affected – among others – by the way the equivalence scale (defined on the basis of the estimated curve's parameters) was used as well as by the nature of the available statistical data. The equivalence scales were supposed to:

- determine the income and expenditure needs of families with children, which would allow the attainment of the economic status of a childless marriage,
- estimate the costs of keeping children in households characterized by various number of children of different age.

The statistical data used for all calculations are aggregate data related to income and expenses (*per capita*) from the Polish CSO publications from 1993 to 2004 and unit data from household budget research carried out by the CSO in 2004.

1. Introduction

The problems of evaluating and comparing the economic status of various groups of households (especially biological families consisting of childless marriages and marriages with different number of children) have been the subject of my research for several years.

The issues connected with these types of biological families were related mainly to the problems of defining the equivalence scales which are the multipliers scaling the incomes and expenses of families of different demographic profile making them liable to comparison[1].

[1] The problem of determining equivalence scales has been in the focus of attention of many Polish and foreign authors. The estimation of equivalence scales for Polish households has been dealt with – among others – by A. Szulc [6-8], G. Betti [1], M. Keane and E. Prasad [4].

The main goal of this paper is to present the results of the empirical research aiming at deciding which variables actually do describe the demographic profile of families for which the estimated Engel's curve matches the empirical data best[2].

The decision which variables to use in this work was affected – among others – by the way the equivalence scale (defined on the basis of the estimated curve's parameters) was used as well as by the nature of the available statistical data.

The equivalence scales were supposed to:

- determine the income and expenditure needs of families with children, which would allow the attainment of the economic status of a childless marriage,
- estimate the costs of keeping children in households characterized by various number of children of different age.

The statistical data used for all calculations is:

- aggregate data related to income and expenses (*per capita*) from Polish CSO publications from 1993 to 2004,
- unit data from household budget research carried out by CSO in 2004.

In studies provided by Polish CSO, there are specified 12 biological types of the family types of families, but in this paper only 6 were considered:

- marriage without children – marked in the following part by (A0),
- marriage with one, two, three and at least four children marked adequately by (A1), (A2), (A3), (A4+) and
- mother or father with children marked by (M+).

2. The place and role of demographic variables for the relative income needs

There are two significantly different approaches used for the equivalence scales' estimation: objective – embracing the so called normative and empirical methods of defining scales; and subjective – where the scales are based on the data collected from the households and related to the households' own perspective on various levels of income.

Among the normative scales, the most commonly used – especially in public statistics in EU countries (mainly in the analyses of income inequality and poverty range) – are the OECD scales with two parameters, calculated as follows:

$$m_{\alpha/\beta} = 1 + \alpha(n_a - 1) + \beta \cdot n_c,$$

where n_a and n_c stand for the number of adults and number of children in the household, respectively, while α and β are arbitrarily set parameters.

[2] The estimated parameters of the Engel's curve are the basis for calculating equivalence scales in Engel's method which is both one of oldest and the most commonly employed method of calculating these scales in empirical research.

In the original (standard) OECD scale type 70/50 $\alpha = 0.7$ and $\beta = 0.5$, which means that according to this scale the coefficient equals 1 for the first adult person, 0.7 for the next adult and 0.5 for every child. In developed EU countries the so named modified OECD scale type 50/30 is becoming more and more often used [3]. Its usage results from the decrease in the share of food expenses in the budget of households in these countries.

Various methods are used to estimate empirical equivalence scales. In Engel's method – one of the oldest, while at the same time most often employed methods – one needs to define the formula of the Engel's curve which describes the relationship between the share of expenses on food in all expenses and various social-economic and demographic characteristics of a household.

In most works one of these variables is the number of children in the family or – if the age structure is also taken into consideration – the number of children in given age brackets. However, such variables do not always reflect the scale's benefits because the marginal effect of the second child or next children is smaller than that of the first child. That is why we often use dummy variables that define whether there are children in the family (or how many there are). While to grasp the non-linearity of the function describing the relationship between the income and the number of children (non-linearity for next children) a logarithm of the number of people in the family is used as the variable[3].

In case of aggregate data, when the only information available is about the number of people in the family and the number of children, the following formulas for the Engel's curve have been applied:

$$w_t^k = \alpha + \beta \ln\left(x_t^k\right) + \eta \ln n_k + \gamma_1 r_1^k + \vartheta_1 \ln p_t + \vartheta_2 \ln p_{gt} + \tau_1 z_1 + \varepsilon, \qquad (1)$$

$$w_t^k = \alpha + \beta \ln\left(x_t^k\right) + \eta \ln(1 + n_c^k) + \vartheta_1 \ln p_t + \vartheta_2 \ln p_{gt} + \sum_{i=1}^{4} \tau_i z_i + \varepsilon, \qquad (2)$$

$$w_t^k = \alpha + \beta \ln\left(x_t^k\right) + \eta \cdot n_c^k + \vartheta_1 \ln p_t + \vartheta_2 \ln p_{gt} + \sum_{i=1}^{4} \tau_i z_i + \varepsilon, \qquad (3)$$

where w_t^k stands for the share of food expenses in all expenses, x_t^k stands for all income or expenses in the household with k children to keep (that is the k-th type of household), $r_1{}^k$ is the quotient of adults and the number of people in the k-th type of household, n_c^k is the number of children in k-th type of household, while z_1, z_2, z_3, and z_4 are dummy variables which equal 1 for household consisting of a single mother with children (type M+), a marriage with one child (A1), with two children

[3] In consumption-related research, the variable which reflects the age of children in a simple and effective way is a variable determining the average age of the children in the household.

(A2) and with three children (A3) respectively and which equal 0 in other types of households.

The parameters used in these formulas have been estimated on the basis of data from the years 1993-2004 by means of the least squares method. While the collected data is cross-section-time data, the global consumer price index P_{gt} and food price index $P_{żt}$ have been taken into consideration in the above mentioned formulas. These indices were originally chain indices and – for the purpose of comparison – have been transformed into fixed-base indices, for which the year 1993 has been fixed as the basic period.

In the Engel's method data about the share of food expenses in all expenses is essential to define the equivalence scales. The share of food expenses in all expenses in years 1993-2004 for chosen types of families is presented on Fig. 1. It can be seen that the decrease in the share of food expenses in all expenses has characterized all family types.

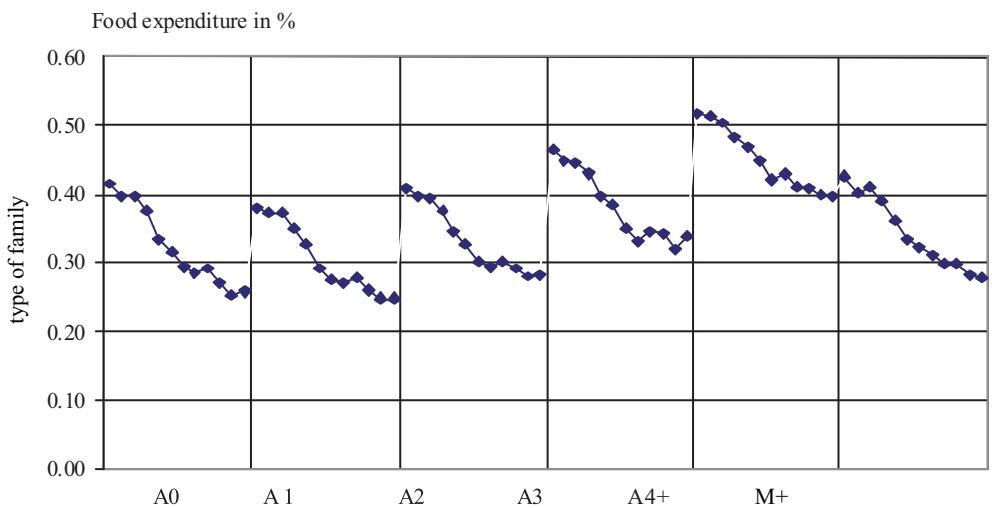

Fig. 1. The share of food expenses in all expenses in years 1993-2004 for chosen types of families

Source: own calculations.

The estimated parameters of all three formulas of Engel's curves are shown in Table 1.

The recurring negative values of estimated β parameter and positive values of estimated η parameter, standing by the variables relating to the size of the household show that the increase in all expenses results in a decrease in the share of food expenses (in *ceteris paribus* conditions). The growth of a household without an increase in expenses implies an increase in this share.

Table 1. Values of the Engel's curves' estimated parameters

Engel's curve from formula (1)									
Parameters	α	β	η	ϑ_1	ϑ_2	τ_1	γ_1		
R^2=0.997	0.92	–0.183	0.346	0.37	–0.234	0.127	0.379		
$\lvert t \rvert$	3.68	5.99	13.45	10.04	3.83	4.55	7.64		
Engel's curve from formula (2)									
Parameters	α	β	η	ϑ_1	ϑ_2	τ_1	τ_2	τ_3	τ_4
R^2=0.992	1.57	–0.188	0.088	0.333	–0.19	–0.098	–0.045	–0.482	–0.321
$\lvert t \rvert$	9.70	7.2	30.10	11.56	3.83	14.22	10.26	11.17	10.79
Engel's curve from formula (3)									
Parameters	α	β	η	ϑ_1	ϑ_2	τ_1	τ_2	τ_3	τ_4
R^2=0.992	1.607	–0.194	0.033	0.333	–0.182	–0.068	–0.016	–0.017	–0.009
$\lvert t \rvert$	9.97	7.45	30.45	11.66	3.71	11.26	2.88	3.42	2.88

Source: own calculations; the *p*-value did not exceed 0.006.

The attempts to include variables z_2, z_3, and z_4 in the set of explanatory variables in the first formula have been unsuccessful; the parameters for these variables were not significantly different from zero. The equivalence scales have been calculated by employing the estimated parameters in the following formulas:

$$S_k = S(A^k) = \frac{x^k}{x^0} = \left(\frac{n_k}{2}\right)^{\left(-\frac{\eta}{\beta}\right)} \cdot e^{\frac{\gamma_1}{\beta}\left(1-n_1^k\right)} \cdot e^{-\frac{\tau_1}{\beta}Z_1}, \tag{4}$$

$$S_k = \left(1+n_c^k\right)^{-\frac{\eta}{\beta}} \exp\left\{-\sum_{i=1}^{4}\frac{\tau_i \cdot z_i}{\beta}\right\}, \tag{5}$$

$$S_k = \exp\left\{-\frac{\eta}{\beta}n_c^k - \sum_{i=1}^{4}\frac{\tau_i}{\beta}z_i\right\}. \tag{6}$$

Table 2 includes the results of the calculations.

Table 2. Equivalence scales calculated with the use of Engel's method

Biological family type	Equivalence scales calculated by use of the formula		
	(4)	(5)	(6)
A0 – marriage without children	1.000	1.000	1.000
A1 – marriage with 1 child	1.042	1.062	1.064
A2 – marriage with 2 children	1.326	1.313	1.312
A3 – marriage with 3 children	1.749	1.747	1.734
A4+ marriage with 4 or more children	2.69	2.659	2.643
M+ mother/father with children	0.929	0.938	0.937

Source: own calculations.

The results obtained with the use of formula (4) should be interpreted as follows: the expenses (costs) of marriages with one, two, three and at least four children, enabling them to attain the standard of living comparable to that of a marriage without children, should be higher by respectively 4.2, 32.6, 74.9, and 169%, while lower by 7.1% for a single mother with children. The interpretation of the scale values obtained by the use of formulas (5) and (6) is analogous.

The results obtained by the use of formulas (4), (5), and (6) are very similar.

It is reflected by Fig. 2 in which the values of the relative income indicator – a quotient of real income and equivalent income – are shown. The equivalent income for family type Ak is a result of multiplying the real income of family type A0 by equivalence scale S_k.

Independently of used Engel's curve and obtained equivalence scales, it is only in marriages with one child that both real income and expenses are higher than the equivalent ones, which means that the income and expenditure situation in this family type is relatively better than in family type A0. In other types of families the real income was too low for those families to attain the material standard of a childless marriage.

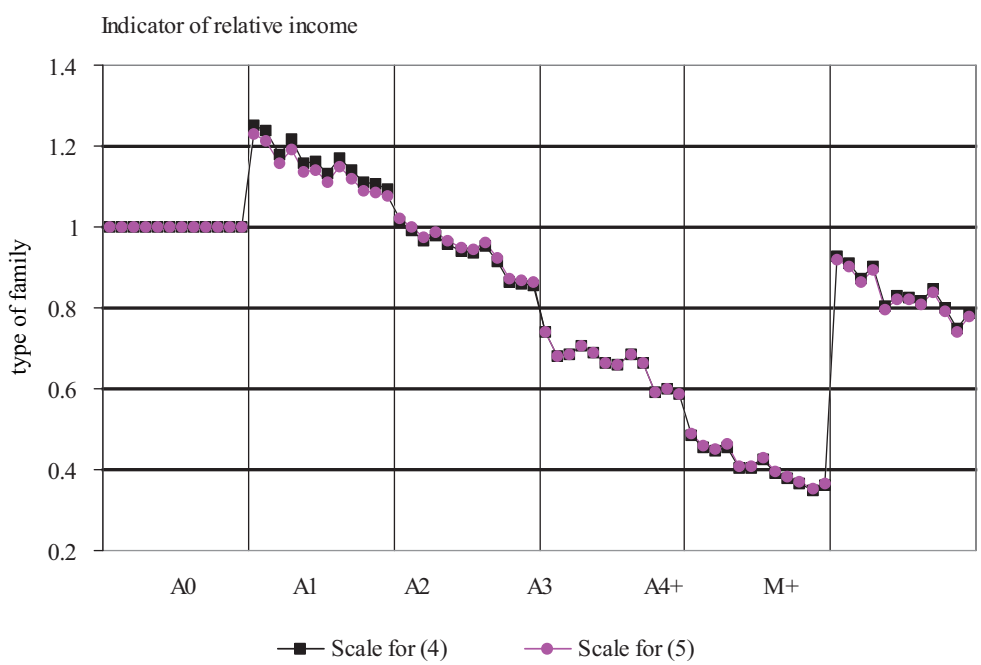

Fig. 2. Relative income indicator for different scales

Source: own calculations.

It is the families with at least three children that are in relatively the worst situation. In these families the real income was lower than the equivalent income by 26-66%.

Similar results obtained by the use of these scales are the main reason why only the scale calculated by means of formula (4) has been used for further analysis.

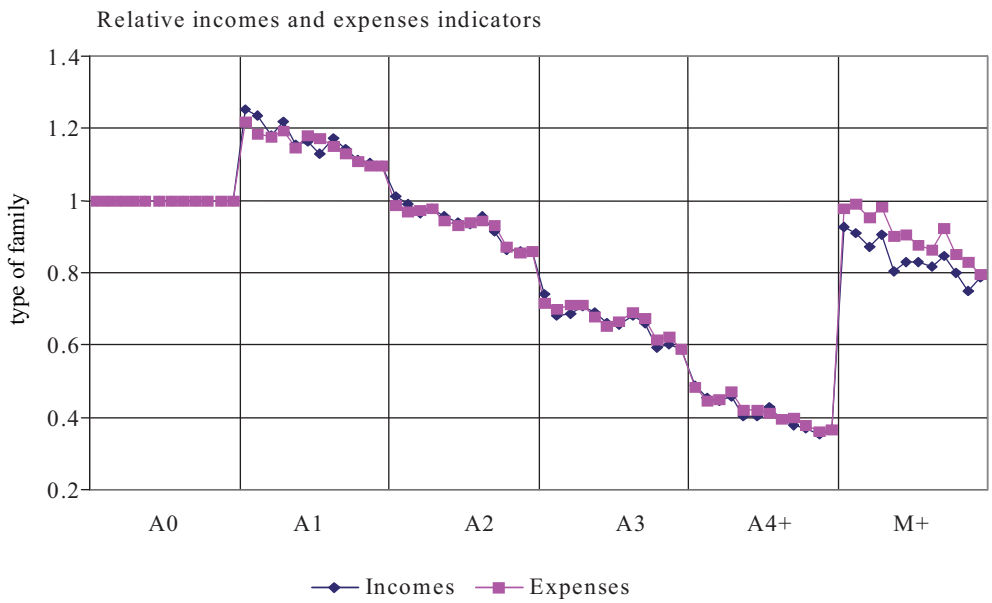

Fig. 3. The dynamics of the relative income indicator and of the relative expenses indicator in years 1993-2004 for all family types

Source: own calculations.

As far as time is concerned, both the relative income indicator and relative expenses indicator give similar results, which means that both income and expenses in households may be used for research related to the relative welfare in the analyzed types of households (Fig. 3).

The biggest differences between relative incomes and expenses can be observed for M+ type families. The relative economic status of these families seems worse when the evaluation is based on the income needs instead of expenses needs.

3. Engel's curves and relative cost of children

The process of calculating the equivalence scales which allowed the estimation of relative costs of keeping children on the basis of data from the household budget research from 2004 has been carried out in two steps.

Firstly, as a result of dividing all the people ascribed to a given household into three groups – parents, children under 14, children over 14 – the parameters have been calculated for the Engel's curves defined in the following formulas:

$$w^k = \alpha + \beta \ln\left(x^k\right) + \eta \ln n_k + \gamma_1 r_1^k + \varepsilon, \tag{7}$$

$$w^k = \alpha + \beta \ln\left(x^k\right) + \eta \ln n_k + \gamma_1 r_1^k + \delta_1 D_1 + \varepsilon, \tag{8}$$

$$w^k = \alpha + \beta \ln\left(x^k\right) + \eta \ln n_k + \gamma_1 r_1^k + \gamma_2 r_2^k + \varepsilon, \tag{9}$$

where: r_2^k – the ratio of the number of children under 14 (marked by n_c) to the number of people in the household,

D_1 – dummy variable which equals 1 when there are children under 14 in the family,

ε – random term,

$r_1^k = 2/n_k$ quotient in case of marriages and $1/n_k$ in case of a single parent with children.

The general shape of equivalence scale calculated by use of the Engel's method on the basis of formulas (7), (8), and (9) is as follows:

$$S_k = \left(\frac{n_k}{2}\right)^{-\frac{\eta}{\beta}} \cdot \exp\left[\frac{\gamma_1}{\beta}\left(1 - r_1^k\right)\right] \cdot \exp\left(-\frac{\gamma_2}{\beta} r_2^k\right) \exp\left(-\frac{\delta_1}{\beta} D_1\right), \tag{10}$$

while the parameters γ_2, δ_1 equal 0 if in the given Engel's curve formula there are no variables related to these parameters.

The estimated parameters of given Engel's curves as well as respective equivalence scales are presented in Tables 3. and 4.

Table 3. Engel's curves' parameters estimations

Engel's curve for formula (7)					
Parameters	α	β	η	γ_1	
R^2=0.512	1.488	–0.188	0.173	0.113	
$\lvert t \rvert$	110.6	131.8	37.27	16.57	
Engel's curve for formula (8)					
Parameters	α	β	η	γ_1	δ_1
R^2=0.516	1.505	–0.189	0.184	0.096	–0.023
$\lvert t \rvert$	111.6	132.7	38.87	13.75	11.25
Engel's curve for formula (9)					
Parameters	α	β	η	γ_1	γ_2
R^2=0.516	1.509	–0.189	0.182	0.096	–0.048
$\lvert t \rvert$	111.25	132.62	38.61	13.67	10.51

Source: own calculations.

At the significance level $\alpha = 0.01$ all estimated parameters in the above mentioned formulas were statistically significant.

Table 4. Equivalence scales for given family types in 2004

Biological family type	Scales calculated on the basis of Engel's curves for formulas							
	(7)	(8)		(9)				
		$D_1 = 0$	$D_1 = 1$	$n_c = 0$	$n_c = 1$	$n_c = 2$	$n_c = 3$	$n_c = 4$
A1	1.189	*1.253*	**1.110**	*1.246*	**1.146**			
A2	1.403	*1.523*	**1.350**	*1.509*	**1.417**	***1.331***		
A3	1.622	*1.799*	**1.594**	*1.777*	**1.690**	***1.607***	***1.528***	
A4	1.844	*2.077*	**1.840**	*2.046*	**1.962**	***1.881***	***1.804***	***1.731***
A4+	1.979	*2.246*	**1.990**	*2.210*	**2.128**	***2.048***	***1.972***	***1.899***
M+1	0.740	*0.776*	**0.687**	*0.776*	**0.685**			
M+2	1.057	*0.937*	**0.847**	*1.053*	**0.968**	***0.890***		

Source: own calculations.

In every calculated scale the higher number of children is matched by a higher equivalence scale value, which means that for such families the relative income needs which would allow the attainment of the economic status of a childless marriage are higher.

By using only the r_1^k variable in the Engel's curve formula (7), the calculated scale was most similar to the modified OECD scale 50/30. The increments in the scale show that the income of the families with a larger number of children should be higher than the income of a childless marriage by 19-22% (20% in the OECD). The introduction of the D_1 variable which equals 1 when there are children under 14 in the family resulted in a decrease of relative income needs to 11% in case of one child in the family and in an increase of about 24% for every next child.

Introduction of other variables, which define the demographic profile of a family, in greater detail resulted in the flattening of the scale. Relative income needs resulting from the use of formula (9) amount to 14.6-20.3% of a childless couple income when all the children in the family are under 14.

In the case when all the children are over 14, the highest values of the scale have been calculated, on almost the same level independently of the way the demographic profile of the family has been described (compare the scale's values for $D_1 = 0$ and $n_c = 0$). The relative income needs for every next child amount to over 25% for a family with one child and almost 28% for a family with four children.

In order to determine the relative costs of keeping children in various age, the following Engel's curve has been applied[4]:

[4] In this case only marriages with children have been taken into consideration. The number of M+ type families with children in various age was very small and these types of families have been excluded.

$$w^k = \alpha + \beta \ln x^k + \eta \ln n_k + \sum_i \varepsilon_i E_i + u, \tag{11}$$

where E_i are dummy variables taking into account the age structure of children in the household. These variables have been defined as follows:

$E_1 = 1$, if all the children in the family are 0-6 years old,
$E_2 = 1$, if all the children in the family are 7-13 years old,
$E_3 = 1$, if all the children in the family are 14-19 years old,
$E_4 = 1$, if all the children in the family are 20-26 years old.

In case of a marriage without children which is the benchmark, all E_i variables equalled 0. Due to the fact that the analysis is related to marriages with children, the quotient r_1 has been omitted in the Engel's curve formula.

In accordance with the Engel's method, the following form of equivalence scale S_k has been calculated for a household with k children in a specified age bracket:

$$S_k = \left(\frac{n_k}{2}\right)^{-\frac{\gamma}{\beta}} \cdot \exp\left(-\frac{1}{\beta}\sum_{i=1}^{4} \varepsilon_i E_i\right). \tag{12}$$

The calculated values of ε_3 and ε_4 parameters' estimations at the significance level of 0.01 have been only slightly different from 0, which resulted in the removal of the variables E_3 and E_4 from the formula (11) and the parameters of the Engel's curve have been re-estimated. The results of these calculations are presented in Table 5.

Table 5. The values of the estimations of the parameters of the Engel's curve described by the formula (11)

Parameters	α	β	η	ε_1	ε_2
$R^2 = 0.55$ $\lvert t \rvert$	1.516 (123.9)	–0.174 (112.87)	0.116 (42.59)	–0.0411 (16.56)	–0.012 (5.03)

Source: own calculations.

On the basis of estimated parameters and using the formula (12) the equivalence scales for given family types have been calculated. As one can see, these scales show a huge differentiation as far as children under 14 are concerned.

In every case the lowest values of the scale characterize the families with children aged 0-6, and the values grow along with the children's age. The highest values of the scale characterize the families, whose children are at least 14 years old.

In the case of the families with the youngest children (under 7) one can observe a huge increment in the relative costs of keeping the second child (from 3.5 to 25.4%), which – for next children – amounts to almost 22 and 19% of the costs of a

childless marriage, which indicates a slight scale benefit resulting from the shared managing. In the case of families with children between 7 and 13 years old, the highest increment of costs (about 26%) comes with the second child, while next children in this group are characterized by a cost amounting to 24 and 22% of a childless marriage keeping costs, respectively. These costs of keeping children under 14 are placed in between the costs calculated by means of the original and the modified OECD scales, which amounted to 29.4 and 20% of childless marriage costs respectively.

Table 6. Equivalence scales taking the age of the children into account[5]

Biological family type	Scales which take children's age into account		
	0-6	7-13	14 and more
A0	1.000	1.000	1.000
A1	1.035	1.223	1.311
A2	1.254	1.482	1.588
A3	1.456	1.720	1.844
A4	1.644	1.943	2.082

Source: own calculations.

These results show that the equivalence scale's values depend a lot on the variables which describe the demographic structure of the family and the character of statistical data (see Table 7).

Table 7. Equivalence scales for various sets of statistical data

Statistical data	Equivalence scales for different type of families					
	A1	A2	A3	A4	A4+	M+
1993-2004	1.064	1.312	1.734	2.168	2.659	0.938
2004	1.118	1.345	1.616	2.031	2.262	0.908

Source: own calculations

All calculations of empirical equivalence scales indicate that when using arbitrary equivalence scales it could be beneficial to employ a scale in between the original and the modified OECD scales – for example 70/40 or 50/40 – and only after some time apply the OECD 50/30 scale recommended by Eurostat.

[5] The obtained equivalence scales are not directly comparable to the scales determined by A. Szulc in [8], even though Engel's method was used in both cases. In the quoted work the point of reference was a one-person household with the age of the person ranging from 30 to 60. Moreover, the age brackets for children were set from 0 to 7 and from 7 to 16; the data, which constituted the basis for the calculation, referred to year 1997.

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CHARAKTERYSTYKA DEMOGRAFICZNA I STATUS EKONOMICZNY RODZIN W POLSCE METODY I WYNIKI BADAŃ

Streszczenie

W artykule zostały zaprezentowane wyniki badań empirycznych, których głównym celem było określenie takich zmiennych istotnie opisujących profil demograficzny rodziny, dla których stopień dopasowania oszacowanej krzywej Engla do danych empirycznych jest największy. Dobór zmiennych podyktowany był przede wszystkim tym, że wyznaczone na podstawie krzywej Engla skale ekwiwalentności miały służyć dwóm podstawowym celom:

- określeniu, jakie są potrzeby dochodowe czy wydatkowe rodzin z dziećmi pozwalające na osiągnięcie statusu ekonomicznego małżeństwa bezdzietnego,
- ocenie kosztów utrzymania dzieci w gospodarstwach o różnej liczbie dzieci i o różnej ich strukturze wiekowej.

Ostateczna postać krzywej Engla zależała również od tego, czy dane statystyczne uwzględnione w badaniu były danymi przekrojowymi czy przekrojowo-czasowymi.

Podstawę wszystkich obliczeń stanowiły dane zagregowane dotyczące dochodów i wydatków (w przeliczeniu na 1 osobę) pochodzące z oficjalnych publikacji GUS za okres od 1993 r. do 2004 r. oraz dane jednostkowe z badań budżetów domowych prowadzonych przez GUS w 2004 r.