

**Hanna Dudek**<sup>1</sup>  
Chair of Econometrics and Statistics  
Warsaw University of Life Sciences  
Warsaw, Poland

## Quantitative analysis of the household's expenditure for food

**Abstract.** The paper deals with the dependence of the share of households' food expenditure on the total expenditure and the household's size. This problem is important in applied welfare economics. According to the Engel's law, the poorer household, the greater proportion of its total expenditure is devoted to the food consumption. In the study, the Working-Leser model was applied to Polish households microeconomic data from 2000, 2005 and 2009.

**Key words:** food consumption, Engel's law, households.

### Introduction

The article focuses on the analysis of share of food expenditure in the total household's expenditure. Food expenditure share is defined as the consumption expenditure on food divided by the total expenditure on consumer goods and services by a household.

The first study bearing on the food expenditures was done by the statistician Ernst Engel who published a study for the Prussian government in 1895. Engel observed an empirical regularity that the food expenditure share in the household budget falls with a rising income. This regularity is known in the economic literature as Engel's law. According to this law 'the poorer a family, the greater the proportion of its total expenditure that must be devoted to the provision of food' or 'the greater the income, the smaller the relative percentage of outlays for subsistence'<sup>2</sup> [Engel 1895]. An allocation of a high share of household budgets to food can be therefore a sign of poverty, hence a quantitative analysis of food share in the total expenditure is a very important problem. In the absence of a universally accepted method of calculating poverty, household expenditures can be used to provide an indication of inequality of wealth distribution and serve as an indicator of poverty [Martins 2007].

The aim of this work is, firstly, to provide an overview of consumption expenditure of Polish households and, secondly, to present econometric estimations of food expenditure share in the total household's expenditure and its elasticities, taking into account the differences in size of households. In this econometric approach the Working-Leser model was used. The model was estimated using household survey microeconomic data collected by the Polish Central Statistical Office.

---

<sup>1</sup> PhD, assistant professor, address: Nowoursynowska 159, 02-787 Warszawa, tel. 0-22 59-34-121, email: hanna\_dudek@sggw.pl.

<sup>2</sup> Translation by Stigler [1954].

## Food expenditure in the European Union member states

Food and beverages are amongst the most important consumption items for the majority of the EU households. There is a great diversity across the European Union as regards the food and non-alcoholic beverage expenditure. Generally, there is still a considerable gap between the new 12 and the old 15 member states of the EU that has a mirror reflection also in the consumer expenditure. For example, in 2005 the highest share of consumption expenditure for the purchase of food and beverages was recorded in Romania (44.2 % of total expenditure) and the lowest in Luxembourg (9.3 %)<sup>3</sup>. It should be noted that during the last years in all the EU countries a drop in the share of food expenditure could be observed. According to Borowska [2006], these changes are minor among the EU-15 countries, while they are more dynamic in the newly acceded countries of the EU.

Some of the differences between and within countries can be related to income. If we consider a breakdown of consumption expenditure by income quintile<sup>4</sup>, we see appreciable differences in EU consumption patterns across the five different income groups (Figure 1).

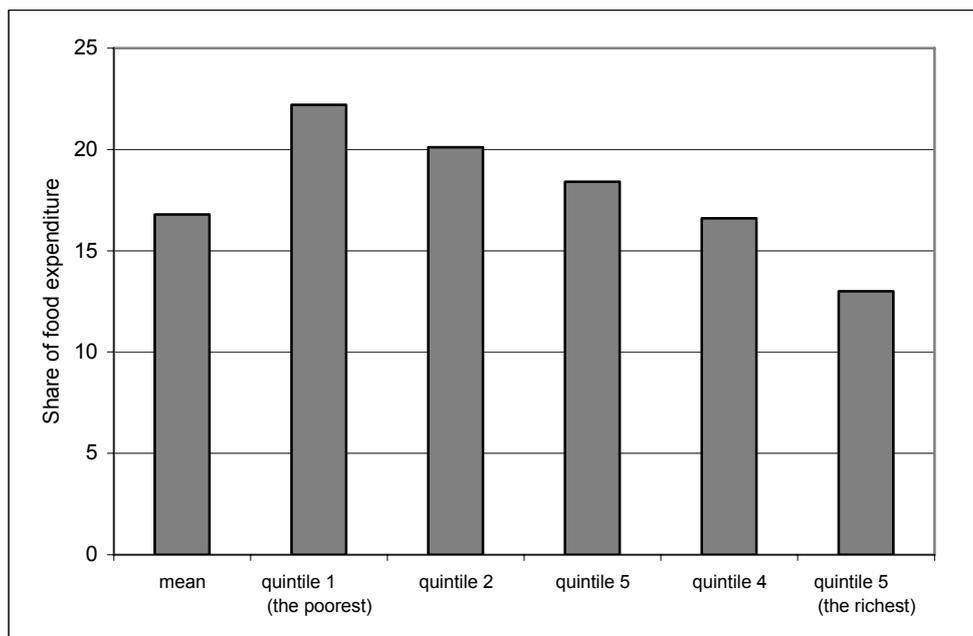


Fig. 1. Share of food and non-alcoholic beverages expenditure in the total household's expenditure by income quintile in the EU-27 in 2005

Source: Eurostat, structure of consumption expenditure by income quintile (hbs\_str\_t223).

<sup>3</sup> The newest data available in the Eurostat database apply to 2005. Like in the other Eurostat reports, an information for the 27 member states of the European Union (EU-27) is presented, although Romania and Bulgaria became the EU members on 1 January 2007.

<sup>4</sup> An income quintile reflects a division of a population into 5 income groups (from the lowest income to the highest income) such that (approximately) 20% of the population is in each group.

The average household expenditure share of expenditure for food and non-alcoholic beverages consumption was about 16.6% in 2005. Food represented more than 22% of the total expenditure of low income households, while it represented only 13% of the total budget of high income group. Therefore, the proportion of total expenditure that was devoted to food and non-alcoholic beverages by the highest income quintile was almost half that recorded by the lowest income quintile in the EU countries.

Share of expenditure for food generally increased with the household's size. For example, on average in the EU-27, single adult households devoted to food and non-alcoholic beverages below 19%, two adults households about 21% and three or more adults households above 22% of their expenditure in 2005.

Results presented here will be compared with the situation in Poland in the later parts of the paper.

## Methods of analysis

Explanation of the food expenditure share may be done parametrically by estimating a functional equation relating the food expenditure to the total expenditure and other household characteristics. For this purpose we employ the so called Working-Leser specification where budget shares are linear in the logarithm of total expenditure<sup>5</sup> [Deaton & Muellbauer 1999, p. 19]:

$$w = \alpha + \beta \ln x + \varepsilon \quad (1)$$

where:

w is the share of expenditure for food in the total expenditure

x is the total household expenditure

$\alpha$  and  $\beta$  are unknown parameters to be estimated,

$\varepsilon$  is an independently identically distributed error with a normal distribution of zero mean and standard deviation of sigma.

Working-Leser specification can be extended to include the effect of household' size:

$$w = \alpha + \beta \ln x + \gamma \ln n + \varepsilon \quad (2)$$

where n is the household size and  $\gamma$  an unknown parameter to be estimated.

In this study, one of the most important concepts in economics, i.e. elasticity, is applied. Elasticity is a measure of the sensitivity of one variable to changes in another variable. Mathematically, if  $y=g(x)$ , then elasticity can be expressed as:

$$E_x y = \frac{g'(x) \cdot x}{g(x)} \quad (3)$$

where  $E_x y$  is the elasticity of y with respect to x.

The elasticity of function  $y=g(x)$  shows the relative change of the dependent variable y due to a unit relative change of the argument x. If we denote food expenditures as f, i.e.  $w=f/x$ , then applying (3) to the Working-Leser model (2) we obtain a formula:

---

<sup>5</sup> The name comes from names of researchers who considered such specifications of demand models [Working 1943; Leser 1963].

$$E_x f = 1 + \frac{\beta}{\alpha + \beta \ln x + \gamma \ln n} \quad (4)$$

Elasticity  $E_x f$  informs about a proportionate change of food expenditure in response to a change in the total expenditure. It varies with the total household expenditure.

## Data

The empirical analysis of this paper is based on household microeconomic data collected by GUS (the Polish Central Statistical Office). The data comes from surveys on Polish household monthly expenditures for the years 2000, 2005 and 2009. The Household Budget Survey (HBS) is a large, representative household survey that is conducted in Poland every year. The HBS plays an important role in the analysis of living standards of population. It is the basic source of information on the revenues and outgoings. The HBS provides, inter alia, detailed information on the level and structure of expenditure, the level and sources of income, the demographic structure of households, i.e. the number of household members, their age, gender, education, disability and economic activity. Household Budget Surveys are based on a sampling method which allows for a generalization of the results to the whole population of households within a margin of an error [Budżety... 2010, p. 26].

The unit of the study is a one-person or a multi-person household. One-person household is defined as a self-sufficient person, i.e. not sharing his/her income with any other person, whether living alone or not. A multi-person household consists of persons living together and sharing their incomes and expenditures. The size of a household is understood as a number of persons included in the household.

Table 1. Summary statistics of food expenditure share in employees' households total expenditure, %

Basic statistics	Year		
	2000	2005	2009
1st quartile	25.40	22.86	20.42
Median	33.54	31.16	28.16
3rd quartile	42.70	40.64	36.84
Average	34.73	32.55	29.37
Standard deviation	13.42	13.60	12.50

Source: author's calculation based on the HBS data.

To ensure a greater homogeneity of data, not the whole HBS sample is considered in the study, but only the employees' households. Their exclusive or prevailing source of livelihood financing is the income from their employment in either public or private sector. Additional sources of income for this group of households may include an old age pension, other types of pension or any unearned income, a self-employment, a private farm or free lancer's income. The income gained from the additional sources is lower than the income from employment [Budżety... 2010, p. 26]. In 2000, the HBS sample include 14509

households of employees, 15822 in 2005, and 18240 in 2009. Outliers<sup>6</sup>, i.e. households with eight and more persons and those with an abnormally high share of food expenditure and value of the total expenditure were excluded. For each household, a share of food and non-alcoholic beverages expenditure in the total expenditure for consumer goods and services were evaluated. Table 1 shows some basic statistics regarding this variable.

Results presented in Table 1 reveal a significant differentiation in the share of food expenditure in the total expenditure of Polish employees' households. For example, one quarter of sampled households expensed on food below 20.42% of the total expenses on consumer goods and services in 2009, but the share of food expenditure exceeded 36.84% in another quarter of sample. Moreover, the variation of food expenditure shares (measured by the coefficient of variation<sup>7</sup>) increased in the decade 2000-2009.

A comparison of results from Table 1 with those from Figure 1 reveals considerable differences between average food expenditure shares in the EU and in Poland. As it was demonstrated in a paper by Dudek and Koszela [2010], the share of food expenditure is significantly correlated with much more complex indices used in other researches for comparing the level of living in different countries. Therefore, one can say that in time in question the situation in Poland was worse than an average situation in the EU. However, decreasing shares of expenditure for food in the total expenses experienced by Polish households during the last decade create an optimistic view of a rapid convergence of Poland with the Western Europe.

## Results

Table 2. Estimates of parameters of model (2)<sup>8</sup>

Estimates of parameters	Year		
	2000	2005	2009
$\alpha$	138.21 (115.98)	138.88 (124.89)	134.07 (133.21)
$\beta$	-15.78 (-94.93)	-15.96 (-105.41)	-14.87 (-114.52)
$\gamma$	11.12 (54.99)	11.89 (67.92)	10.46 (69.02)

Source: author's calculation using STATA software.

A regression analysis confirmed the Engel's law. We obtained a negative sign for the total expenditure as a determinant of the food expenses share in the total expenditure. In contrast, the number of persons in a household turns out to be a positive factor for this share. Detailed estimation results are presented in Table 2. The estimates of *t*-statistic values (rounded to two decimal places) are reported in this table in parentheses<sup>9</sup>.

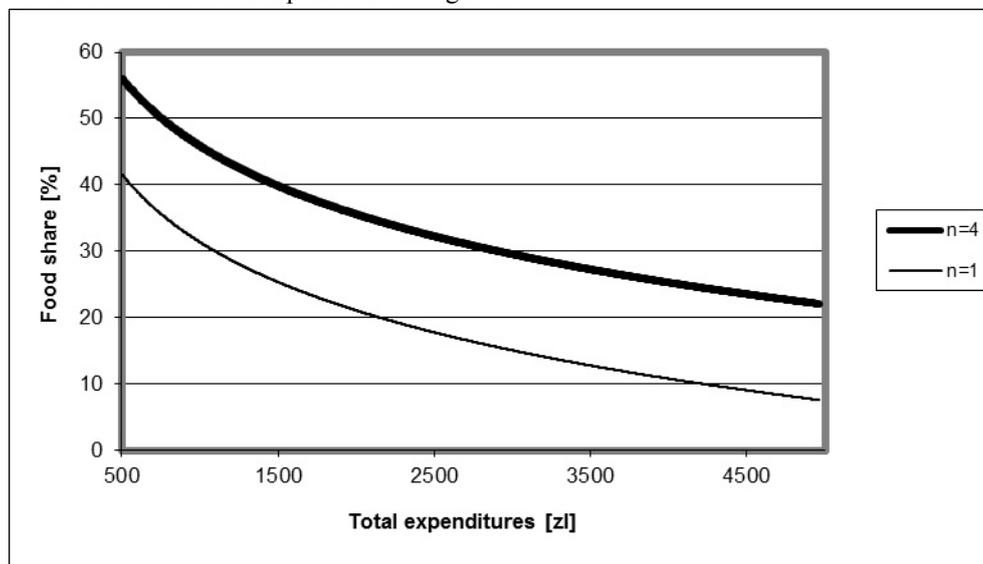
<sup>6</sup> Outliers are extreme values of observed variables that can distort estimates of regression coefficients.

<sup>7</sup> Coefficient of variation (V) is defined as a ratio of the standard deviation to the average. For the data in question V = 38.64% in 2000, V = 41.78% in 2005 and V = 2,58% in 2009.

<sup>8</sup> In all estimated models the food expenditure shares are expressed in % and the total expenditure in PLN. A household size is measured by the number of people in the household.

<sup>9</sup> Robust standard errors were calculated due to the heteroscedasticity in the models. All parameters of the Working-Leser model are statistically significant as indicated by the *t*-statistics. As in other empirical researches based on the HBS data, the R<sup>2</sup> coefficients in the Working-Leser models have not very high values [Holcomb,

Differences between shares of food expenditure depending on the household size for the range of total expenditure on consumer goods and services between 500 PLN/month and 5000 PLN/month are presented in Figure 2.



n = number of family members

Fig. 2. Shares of expenditure for food and non-alcoholic beverages in the total monthly expenditure on consumer goods and services in 2009

Source: author's elaboration.

A drop of food expenditure shares in various demographic types of households, caused by an increase of total expenditure, is illustrated in Figure 2. For example, one-person households with a total monthly expenditure of 1600 PLN devoted to food about 24% of the total expenditure while in four-person households with 1600 PLN of the total monthly expenditure (i.e. 400 PLN per capita) the share of food expenditure was about 39%. Results presented in Table 2 and in Figure 2 were used to calculate the appropriate elasticities. In order to do this, formula (4) was applied. The 95% confidential intervals are reported in parentheses (rounded to two decimal places). The quartiles were calculated separately in each year for the whole sample of employees' households.

The results provided in Table 3 show that the estimates of elasticities of food expenditure in 2005 and in 2009 were very similar, while for 2000 they were bigger than in the later years. For example in one-person households whose total expenditure was on an average level (represented by the median), one percent increase of the total expenditure caused a growth in the expenditure for food by 0.26 % in 2000, while by 0.15% in 2009.

Consistent with Engel's law, households with lower total expenditure make bigger changes in food expenditure than those with higher total consumption expenditure. For example in four-person households, a 10-percent increase in the total expenditure is

---

Park & Capps 1995]. In the present study in the Polish employees' households analysis, they varied from 0.45 to 0.50.

estimated to increase the food expenditure by 4.5% for the better-off Polish households, but by 6 percent for poorer households (first and third quartiles respectively) in 2009.

Table 3. Elasticity of food expenditure with regard to the total expenditure on consumer goods and services and the household size

Distribution of the total expenditure on consumer goods and services	Year		
	2000	2005	2009
	One-person households		
1st quartile	0.40 (0.39; 0.42)	0.33 (0.31; 0.34)	0.34 (0.33; 0.36)
2nd quartile (median)	0.26 (0.24; 0.29)	0.13 (0.10; 0.16)	0.15 (0.13; 0.17)
3rd quartile	0.02 (-0.02; 0.07)	-0.24 (-0.29; -0.18)	-0.21 (-0.26; -0.16)
	Two-person households		
1st quartile	0.54 (0.53; 0.55)	0.50 (0.49; 0.51)	0.50 (0.49; 0.51)
2nd quartile (median)	0.46 (0.44; 0.47)	0.40 (0.39; 0.41)	0.40 (0.39; 0.41)
3rd quartile	0.34 (0.32; 0.36)	0.24 (0.22; 0.26)	0.24 (0.22; 0.26)
	Three-person households		
1st quartile	0.59 (0.58; 0.60)	0.57 (0.56; 0.57)	0.56 (0.55; 0.57)
2nd quartile (median)	0.53 (0.52; 0.54)	0.49 (0.48; 0.50)	0.49 (0.48; 0.50)
3rd quartile	0.44 (0.42; 0.46)	0.38 (0.37; 0.40)	0.37 (0.36; 0.39)
	Four-person households		
1st quartile	0.62 (0.61; 0.63)	0.60 (0.50; 0.61)	0.60 (0.59; 0.60)
2nd quartile (median)	0.57 (0.56; 0.58)	0.54 (0.53; 0.55)	0.53 (0.53; 0.54)
3rd quartile	0.50 (0.49; 0.51)	0.46 (0.44; 0.47)	0.45 (0.43; 0.46)

Source: author's calculation using STATA software.

## Concluding remarks

The application of data analysis for food expenses share in the total consumption expenditure resulted in estimation of regression coefficients coherent with the economic theory. According to the Engel's law, the shares of food expenditure in Poland were inversely related to the logarithm of total expenditure. Consequently, at lower total expenditure levels the percentage of food expenditure is greater. Moreover, the results of the analysis reveal that basic demographic characteristics of households, such as the household's size, have direct effects on the consumption patterns of households.

On the one hand, the average level of share of food expenditure by employees' households decreased in the decade 2000-2009. This phenomena creates an optimistic view of convergence of Poland with the better-off Western European countries. On the other hand in the period in question, an increasing variation of the relative level of food expenditure was observed in Polish households. This means a growth of diversification with regard to living conditions in Poland.

## References

- Borowska A. [2006]: Zmiany w wydatkach gospodarstw domowych dziesięciu nowych członków Unii Europejskiej. [In:] Rolnictwo i gospodarka żywnościowa Polski w ramach Unii Europejskiej, H. Manteuffel Szoega, W.E. Tyner (eds.). Wydawnictwo SGGW, Warsaw, pp. 399-407.
- Budżety gospodarstw domowych. [2010]. GUS Statistical Publishing House, Warsaw.
- Deaton A. [1997]: *The Analysis of Household Surveys: a Microeconomic Approach to Development Policy*. Johns Hopkins University Press, Baltimore.
- Deaton A., Muellbauer J. [1999]: *Economics and Consumer Behavior*. Cambridge University Press, Cambridge.
- Dudek H., Koszela G. [2010]: Udział wydatków na żywność a poziom życia w krajach Unii Europejskiej. *Roczniki Naukowe SERiA* vol. 12, no. 1, pp. 48-52.
- Engel E. [1895]: Die Lebenskosten Belgischer Arbeiter-Familien Fruher und Jetzt. *International Statistical Institute Bulletin* vol. 9, pp. 1-74.
- Holcomb R.B., Park J.L., Capps Jr. O. [1995]: Revisiting Engel's Law: Examining Expenditure Patterns for Food at Home and Away From Home. *Journal of Food Distribution Research* vol. 26, no. 3, pp.1-8.
- Leser C.E.V. [1963]: Forms of Engel Functions. *Econometrica* vol. 31, pp. 694-703.
- Martins J.H. [2007]: Household Budgets as a Social Indicator of Poverty and Inequality in South Africa. *Social Indicators Research* vol. 81, pp. 203-221.
- Stigler G. J. [1954]: The Early History of Empirical Studies of Consumer Behaviour. *Journal of Political Economy* vol. 62, no. 2, pp. 95-113.
- Working H. [1943]: Statistical Laws of Family Expenditure. *Journal of the American Statistical Association* vol. 38, pp. 43-56.