ՏՆՏԵՍԱՄԱԹԵՄԱՏԻԿԱԿԱՆ ՄՈԴԵԼԱՎՈՐՈՒՄ

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FOOD CONSUMPTION DEPENDING ON THE SIZE OF HOUSEHOLD

This article presents structural parameters of linear causal-descriptive models estimated for 45 assortment groups. The computation was carried out separately for subsequent years from 2006 to 2015 and was based on data from the Central Statistical Office of Poland. The models were verified by assessing the fitting theoretical values to empirical data and checking the significance of structural parameter associated with the independent variable. As a result, food categories were determined for which linear function is a good approximation describing the stochastic relationship between the consumption per capita and the size of household as well as such food items for which the relationship is nonlinear. The first group consists of 39 out of 45 assortment items, and the second one includes only six items, namely: bread, flour, milk, potatoes, beetroots and sugar.

Key words: *food consumption, size of household, linear causal-descriptive model, regression model, verification of econometric model.*
JEL: C51, C52, D1, D12

1. Introduction

Consumption is being made to meet needs. The organism is the main cause of human needs. In the hierarchy of human needs, biological needs are absolutely fundamental ones, the most intensely felt, vital to life, and thus the most urgent to be satisfied. They result primarily from the physiological basis of existence and are characterized by the prevalence[1]. The distinctive feature of biological needs is that they can be met in different ways, but it is impossible not to meet them at all. Therefore, they have the rank of objective ones[2]. Undoubtedly, satisfying hunger and thirst belongs to the category in question, hence the consumption of food and non-alcoholic beverages was and still is an important subject of research conducted by economists.

In turn, covering higher order needs is not necessary to maintain life functions of a human being. They have their source in the human psyche or are derived from existing social relations. They are not related to a direct imperative and arise only if basic needs are already fulfilled. The intensity of feeling of higher order needs is much more varied among people than it is in the case of biological ones[3] and to a large extent depends on the level of education of an individual[4].

Conducting research on budgets of households helps to analyse the living standard of different population groups. In particular, such a survey provides an opportunity to compare consumption *per capita* among certain population groups and assess how a range of factors affects the consumption level and its dispersion. Food and non-alcoholic beverages have still the biggest share in the expense structure of Polish households, in 2015 they amounted to about 24,0 per cent of total expenses and above 25,2 per cent of expenses on goods and services[5].

Consumption of food and non-alcoholic beverages *per capita* varies and depends on the size of household measured by the number of people living there. Therefore, the main aim of this article is to seek a model adequately describing the relationship between the consumption *per capita* of certain food categories and the size of household. Finding such a model will help to indicate those food products for which the relationship is linear and those for which the linear function is not a good approximation.

Each of separate food categories was analysed and within those categories a series of subcategories were determined what resulted in 45 assortment items. The research was conducted from 2006 to 2015 for each year separately. The entire computation procedure was repeated 450 times (i.e. 45 assortment items × 10 years).

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[1] **Turczak A.,** Zrgżnicowanie wydatkgw na żywność i napoje bezalkoholowe gospodarstw domowych o rgżnej wielkości [Differentiation of expenses on food and soft drinks by households of different size], Konsumpcja i Rozwgj Nr 1/2017 (18) [Consumption and Development No. 1/2017 (18)], pp. 57–58.

[2] **Bombol M.,** Potrzeby konsumenta [Consumer's needs], (in:) Janoś-Kresło M., Mrgz B. (Eds.), Konsument i konsumpcja we wspgłczesnej gospodarce [Consumer and consumption in the contemporary economy], Oficyna Wydawnicza SGH [Publishing House SGH], Warsaw 2009, pp. 57–58.

[3] **Stępień S., Polcyn J.,** Globalne i regionalne uwarunkowania rozwoju sektora żywnościowego na świecie [Global and regional conditions for the development of the food sector in the world], (in:) **Polcyn J., Głowski P.** (Eds.), Rozwgj regionalny i jego determinanty [Regional development and its determinants], Tom II [Vol. II], Państwowa Wyższa Szkoła Zawodowa im. Stanisława Staszica w Pile [Stanisław Staszic University of Applied Sciences in Piła], Piła 2015, p. 167.

[4] **Polcyn J.,** Edukacja jako dobro publiczne – prgba kwantyfikacji [Education as a public good – an attempt at quantification], Państwowa Wyższa Szkoła Zawodowa im. Stanisława Staszica w Pile [Stanisław Staszic University of Applied Sciences in Piła], Piła 2017, pp. 146–153.

[5] Household budget survey in 2015, Central Statistical Office of Poland (CSO), Warsaw 2016, p. 116.

The sources of all the necessary data used in computation were materials provided by the Central Statistical Office of Poland (CSO): *Household budget survey in 2006* (*2007*, *2008*, *2009*, *2010*, *2011*, *2012*, *2013*, *2014*, *2015*). What is worth mentioning, CSO carries out the survey on household budgets using the representative method which allows for generalising the results to all the households in Poland[6]. The data on average monthly consumption *per capita*, denominated in kilograms, liters or pieces, were used in this article.

The following research procedure consisting of three stages was conducted for each year and each 45 food category (subcategory):

1. estimation of structural parameters for linear causal-descriptive model with one independent variable;
2. verification of obtained econometric model by:

2.1. assessing whether the model fits the empirical data,

2.2. examining the significance of structural parameter associated with the independent variable.

This article tests the research hypothesis that for most of the assortment groups under analysis linear function is a good approximation to reflect the relationship between mean monthly consumption *per capita* and the size of household as well as it tests two auxiliary hypotheses that for each food category structural parameters estimated for linear causal-descriptive model are relatively stable from 2006 to 2015 and an increase in the size of household leads to a decrease in consumption *per capita* in each assortment group. Positive verification of all these hypotheses will allow to conclude that regardless whether the size of household increases from one to two, from two to three, from three to four etc., always the increase in household size by one person will cause the decrease in consumption *per capita* by – more or less – constant quantity.

The nature of this article is the research one.

2. Applied research tools

Linear regression model with one independent variable is shown as follows[7]:

$$y_i^* = a_0 + a_1 x_i \ ,$$

where:

x_i – values of explanatory (independent) variable;

y_i – empirical data of explained (dependent) variable;

y_i^* – theoretical values of explained variable;

i – subsequent number of observation $(i = 0, 1, ..., n)$;

n – total number of observations;

a_0 , a_1 – parameter estimates for the model.

[6] The same reference as above, p. 14.

[7] **Helbæk M., McLellan B.,** Essentials of management science, PEARSON Prentice Hall, Harlow 2010, p. 150.

Structural parameters of the econometric model may be computed with the use of the given formulas[8]:

$$a_1 = \frac{\overline{y \cdot x} - \overline{y} \cdot \overline{x}}{\overline{x^2} - \overline{x}^2} \qquad \text{and} \qquad a_0 = \overline{y} - a_1 \cdot \overline{x},$$

where:

$\overline{x}$, $\overline{y}$ – arithmetic mean of X and Y variables respectively.

Statistical verification of the model is based mainly on considering whether the model fits the empirical data and determining the significance of structural parameter assigned to the independent variable. In order to judge whether the model fits the empirical observations, the coefficient of determination may be calculated. It is computed with the use of the following equation[9]:

$$R^2 = \frac{\sum_{i=1}^{n}\left(y_i^* - \overline{y}\right)^2}{\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2}.$$

The coefficient of determination is a dimensionless quantity and for interpretation purposes it is expressed in per cent. It is a normalized value and ranges only within the following interval: $\langle 0;1 \rangle$. $R^2 = 1$ proves a perfect fit[10].

In order to assess the quality of the econometric model also significance of structural parameter associated with the independent variable is tested, namely it is checked whether the parameter is significantly different from zero[11]. In order to do so, the following equation is used:

$$t_1 = \frac{|a_1|}{D(a_1)},$$

where $D(a_1)$ is the standard error of estimate in tested parameter. In the case of linear causal-descriptive model with one independent variable, the standard error of estimate $D(a_1)$ is computed in the following manner[12]:

$$D(a_1) = \frac{S_e}{\sqrt{n\left(\overline{x^2} - \overline{x}^2\right)}},$$

where S_e is the mean error of estimate in the model calculated as follows[13]:

[8] **Asteriou D., Hall S.G.,** Applied econometrics. A modern approach, PALGRAVE MACMILLAN, New York 2007, p. 28.

[9] **Stock J.H., Watson M.W.,** Introduction to econometrics, PEARSON Addison Wesley, Boston 2007, pp. 123–124.

[10] **Welfe A.,** Ekonometria. Metody i ich zastosowanie [Econometrics. Methods and their application], PWE, Warsaw 2009, p. 41.

[11] **Keller G., Warrack B.,** Statistics for management and economics, Brooks/Cole - Thomson Learning, Pacific Grove 2003, p. 620.

[12] **Nowak E.,** Zarys metod ekonometrii [Outline of econometrics methods], PWN, Warsaw 2002, p. 38.

[13] Heij Ch., de Boer P., Frenses P.H., Kloek T., van Dijk H.K, *Econometric methods with applications in business and economics*, OXFORD University Press, New York 2004, p. 100.

$$S_e = \sqrt{\frac{\sum_{i=1}^{n}\left(y_i - y_i^*\right)^2}{n-2}}\ .$$

In order to prove the significance of structural parameter assigned to the independent variable, it is necessary to use Student *t* distribution and for $n-2$ degrees of freedom and the assumed significance level α to find the critical value t_α [14]. Then, if $|t_1| > t_\alpha$, the parameter is significant i.e. the explanatory variable *X* affects significantly the explained variable *Y*. When the inequality $|t_1| \le t_\alpha$ is fulfilled, the tested structural parameter is insignificant[15].

3. Estimation of model structural parameters

The study focused on six types of households: 1-person, 2, 3, 4, 5 and 6-people and more. The observations of independent variable *X* are as follows: $x_1 = 1$, $x_2 = 2$, $x_3 = 3$, $x_4 = 4$, $x_5 = 5$ and the value x_6 obtained by dividing the total number of people in households classified as „6-people and more" by the number of such households. The received quotient x_6 is: 6.63 in 2006, 6.63 in 2007, 6.65 in 2008, 6.64 in 2009, 6.65 in 2010, 6.64 in 2011, 6.60 in 2012, 6.63 in 2013, 6.64 in 2014 and 6.56 in 2015.

It was assumed in the first stage of the study that the stochastic relationship between the size of household and mean monthly consumption *per capita* of particular foodstuffs is linear. Then, the structural parameters of estimated regression models are the figures shown in Tables 1 & 2.

Hence, the first regression model after the parameter estimation is: $y_i^* = 10.433 - 0.575x_i$ (for bread and cereals in 2006). Value $a_1 = -0.575$ means that when the explanatory variable *X* increases by a unit, then the explained variable *Y* decreases by 0.575 units. Thus in such a case, the increase in the size of household by one person results in the decrease in bread and cereals consumption *per capita* by ca. 0.575 kg. While parameter a_0 has no economic interpretation.

Analysis of data shown in Table 1 allows for drawing the following conclusion: for all the food groups and subgroups of foodstuffs (45) and within the time under consideration (2006–2015) the value of estimated parameter a_1 is negative. It means that for each out of 450 models, the increase in the size of household results in the decrease in mean monthly consumption per capita.

Moreover, outcomes in each line of Table 1 are similar. The same conclusion may be drawn on the basis of analysis of outcomes in Table 2. Therefore, it can be said that the structural parameters a_0 and a_1 of linear regression models are quite stable.

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[14] Dougherty Ch., *Introduction to econometrics*, OXFORD University Press, New York 2002, p. 96.

[15] Czyżycki R., Hundert M. and Klgska R., *Wybrane zagadnienia z ekonometrii* [*Selected issues of econometrics*], ECONOMICUS, Szczecin 2004, p. 64.

Table 1

Structural parameters a_1 of estimated models

Foodstuffs:	Years									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bread and cereals in kg, of which:	-0.575	-0.592	-0.559	-0.532	-0.545	-0.550	-0.531	-0.516	-0.504	-0.546
rice	-0.049	-0.045	-0.041	-0.039	-0.038	-0.034	-0.032	-0.034	-0.030	-0.029
bread	-0.236	-0.263	-0.243	-0.233	-0.235	-0.247	-0.233	-0.225	-0.224	-0.259
pasta	-0.056	-0.056	-0.051	-0.052	-0.051	-0.047	-0.047	-0.046	-0.044	-0.047
flour	-0.060	-0.063	-0.063	-0.047	-0.057	-0.055	-0.057	-0.047	-0.039	-0.042
Meat in kg, of which:	-0.546	-0.545	-0.574	-0.574	-0.584	-0.597	-0.596	-0.593	-0.613	-0.637
raw meat	-0.282	-0.292	-0.289	-0.276	-0.304	-0.303	-0.306	-0.323	-0.333	-0.349
poultry	-0.178	-0.182	-0.183	-0.173	-0.180	-0.185	-0.197	-0.196	-0.188	-0.189
processed meat and other meat preparations	-0.240	-0.230	-0.231	-0.272	-0.259	-0.272	-0.271	-0.229	-0.238	-0.240
Fish and seafood in kg	-0.080	-0.082	-0.084	-0.083	-0.085	-0.082	-0.078	-0.064	-0.060	-0.063
Milk in l	-0.296	-0.301	-0.253	-0.259	-0.245	-0.261	-0.231	-0.239	-0.216	-0.240
Yogurt in kg	-0.065	-0.071	-0.065	-0.075	-0.089	-0.085	-0.083	-0.081	-0.078	-0.074
Cheese and curd in kg, of which:	-0.131	-0.123	-0.124	-0.137	-0.145	-0.143	-0.138	-0.137	-0.134	-0.138
curd	-0.081	-0.079	-0.078	-0.087	-0.096	-0.096	-0.093	-0.090	-0.085	-0.090
ripening and melted cheese	-0.049	-0.044	-0.042	-0.049	-0.051	-0.045	-0.047	-0.047	-0.049	-0.048
Cream in l	-0.054	-0.055	-0.056	-0.059	-0.056	-0.058	-0.055	-0.056	-0.055	-0.058
Eggs in units	-1.623	-1.651	-1.559	-1.601	-1.561	-1.538	-1.635	-1.572	-1.605	-1.683
Oils and other fats in kg, of which:	-0.178	-0.171	-0.167	-0.168	-0.164	-0.159	-0.156	-0.150	-0.146	-0.151
animal fats	-0.085	-0.079	-0.074	-0.077	-0.073	-0.072	-0.069	-0.065	-0.066	-0.070
butter	-0.060	-0.058	-0.054	-0.056	-0.051	-0.051	-0.050	-0.051	-0.051	-0.051
vegetable fats	-0.095	-0.092	-0.093	-0.090	-0.092	-0.086	-0.088	-0.084	-0.080	-0.081
Fruit, nuts and processed fruit in kg, of which:	-0.645	-0.607	-0.637	-0.657	-0.651	-0.648	-0.644	-0.663	-0.704	-0.729
fruit	-0.620	-0.583	-0.615	-0.631	-0.623	-0.616	-0.615	-0.633	-0.671	-0.697
citrus fruit and bananas	-0.181	-0.190	-0.192	-0.181	-0.202	-0.211	-0.196	-0.213	-0.220	-0.228
apples	-0.232	-0.224	-0.212	-0.217	-0.228	-0.209	-0.213	-0.209	-0.214	-0.219
berries	-0.087	-0.075	-0.095	-0.100	-0.080	-0.078	-0.085	-0.083	-0.094	-0.099
nuts and processed fruit	-0.024	-0.024	-0.024	-0.026	-0.027	-0.029	-0.028	-0.029	-0.032	-0.033

Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Vegetables, mushrooms, processed vegetables and mushrooms in kg, of which:	-1.161	-1.163	-1.109	-0.996	-0.951	-1.070	-1.009	-1.048	-1.086	-1.146
potatoes	-0.368	-0.398	-0.340	-0.246	-0.191	-0.267	-0.201	-0.240	-0.252	-0.293
other vegetables and mushrooms	-0.669	-0.635	-0.646	-0.619	-0.621	-0.676	-0.678	-0.644	-0.667	-0.684
cabbage	-0.061	-0.075	-0.064	-0.056	-0.050	-0.054	-0.056	-0.057	-0.052	-0.054
tomatoes	-0.164	-0.154	-0.162	-0.157	-0.155	-0.186	-0.169	-0.169	-0.170	-0.176
cucumbers	-0.061	-0.044	-0.060	-0.057	-0.052	-0.060	-0.068	-0.056	-0.066	-0.065
beetroots	-0.028	-0.022	-0.014	-0.016	-0.021	-0.020	-0.021	-0.018	-0.017	-0.023
carrots	-0.062	-0.059	-0.060	-0.055	-0.059	-0.059	-0.061	-0.059	-0.059	-0.059
processed vegetables and mushrooms	-0.115	-0.122	-0.118	-0.124	-0.132	-0.122	-0.124	-0.130	-0.136	-0.134
Sugar, jam, honey, chocolate and confectionery in kg, of which:	-0.190	-0.178	-0.174	-0.152	-0.156	-0.156	-0.152	-0.168	-0.172	-0.178
sugar	-0.124	-0.117	-0.113	-0.090	-0.090	-0.088	-0.082	-0.081	-0.080	-0.082
chocolate	-0.015	-0.014	-0.013	-0.013	-0.013	-0.014	-0.015	-0.023	-0.023	-0.025
confectionery	-0.021	-0.021	-0.021	-0.023	-0.026	-0.027	-0.027	-0.019	-0.021	-0.022
Coffee, tea and cocoa in kg, of which:	-0.048	-0.046	-0.045	-0.042	-0.044	-0.042	-0.041	-0.042	-0.042	-0.042
coffee	-0.029	-0.030	-0.029	-0.028	-0.030	-0.028	-0.029	-0.029	-0.029	-0.029
tea	-0.017	-0.017	-0.013	-0.014	-0.014	-0.014	-0.012	-0.012	-0.013	-0.013
Mineral and spring waters in l	-0.586	-0.554	-0.539	-0.596	-0.688	-0.645	-0.653	-0.642	-0.635	-0.729
Fruit and vegetable juices in l	-0.168	-0.140	-0.128	-0.119	-0.110	-0.107	-0.085	-0.087	-0.089	-0.092

Source: *own computation based on CSO materials: Household budget survey in 2006, (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015), Warsaw 2007: pp. 108–125; 2008: pp. 124–141; 2009: pp. 142–159; 2010: pp. 138–155; 2011: pp. 150–167; 2012: pp. 146–163; 2013: pp. 170–187; 2014: pp. 170–187; 2015: pp. 170–187.*

Table 2

Structural parameters a_0 of estimated models

Foodstuffs:	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bread and cereals in kg, of which:	10.433	10.121	9.723	9.372	9.253	8.951	8.731	8.522	8.290	8.238
rice	0.419	0.391	0.365	0.352	0.349	0.324	0.305	0.313	0.289	0.286
bread	6.585	6.400	6.105	5.842	5.670	5.503	5.342	5.069	4.870	4.798
pasta	0.594	0.604	0.571	0.574	0.565	0.541	0.545	0.555	0.537	0.554
flour	1.260	1.171	1.145	1.091	1.117	1.053	1.049	0.955	0.924	0.892
Meat in kg, of which:	7.519	7.506	7.837	7.796	7.847	7.810	7.712	7.535	7.649	7.716
raw meat	4.171	4.191	4.213	4.133	4.269	4.227	4.163	4.192	4.276	4.358
poultry	2.217	2.157	2.195	2.174	2.233	2.241	2.292	2.259	2.256	2.265
processed meat and other meat preparations	3.124	3.099	3.117	3.441	3.367	3.382	3.359	2.925	2.953	2.924
Fish and seafood in kg	0.728	0.763	0.797	0.780	0.781	0.738	0.714	0.583	0.555	0.563
Milk in l	5.394	5.117	4.730	4.622	4.572	4.522	4.365	4.322	4.152	4.132
Yogurt in kg	0.611	0.703	0.683	0.758	0.873	0.857	0.833	0.812	0.790	0.772
Cheese and curd in kg, of which:	1.388	1.349	1.353	1.445	1.500	1.487	1.469	1.344	1.325	1.357
curd	0.840	0.821	0.818	0.863	0.925	0.928	0.912	0.789	0.758	0.779
ripening and melted cheese	0.545	0.527	0.525	0.582	0.582	0.552	0.560	0.558	0.569	0.581
Cream in l	0.626	0.619	0.618	0.628	0.601	0.599	0.591	0.586	0.578	0.574
Eggs in units	20.471	20.044	19.263	19.360	19.062	18.671	18.921	18.353	18.336	18.373
Oils and other fats in kg, of which:	2.171	2.099	2.058	2.046	2.003	1.945	1.922	1.820	1.788	1.746
animal fats	0.834	0.784	0.738	0.746	0.707	0.671	0.649	0.593	0.593	0.609
butter	0.543	0.528	0.495	0.505	0.469	0.453	0.439	0.445	0.446	0.461
vegetable fats	1.341	1.315	1.320	1.294	1.297	1.268	1.278	1.226	1.196	1.137
Fruit, nuts and processed fruit in kg, of which:	6.048	5.753	6.048	6.325	5.948	5.789	5.913	5.964	6.294	6.367
fruit	5.823	5.525	5.822	6.083	5.693	5.518	5.655	5.702	6.023	6.090
citrus fruit and bananas	1.529	1.687	1.726	1.639	1.818	1.864	1.756	1.918	1.959	2.025
apples	2.414	2.203	2.096	2.207	2.155	1.929	2.095	1.951	2.014	1.951
berries	0.817	0.711	0.868	0.913	0.736	0.693	0.735	0.742	0.826	0.844
nuts and processed fruit	0.221	0.228	0.233	0.241	0.253	0.260	0.249	0.259	0.268	0.277

Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Vegetables, mushrooms, processed vegetables and mushrooms in kg, of which:	15.693	15.405	14.963	14.297	13.806	14.145	13.532	13.128	13.215	13.104
potatoes	7.255	7.248	6.724	6.149	5.707	5.857	5.235	5.021	4.940	4.853
other vegetables and mushrooms	7.131	6.827	6.923	6.787	6.671	6.973	6.956	6.520	6.686	6.613
cabbage	0.859	0.914	0.845	0.823	0.766	0.761	0.761	0.711	0.683	0.664
tomatoes	1.488	1.416	1.501	1.460	1.367	1.604	1.480	1.477	1.489	1.515
cucumbers	0.905	0.760	0.828	0.794	0.829	0.831	0.860	0.724	0.774	0.767
beetroots	0.402	0.372	0.331	0.329	0.332	0.312	0.323	0.285	0.280	0.291
carrots	0.825	0.799	0.797	0.763	0.767	0.757	0.772	0.731	0.732	0.698
processed vegetables and mushrooms	1.211	1.246	1.238	1.278	1.351	1.246	1.267	1.326	1.338	1.355
Sugar, jam, honey, chocolate and confectionery in kg, of which:	2.706	2.580	2.570	2.448	2.392	2.288	2.277	2.545	2.566	2.531
sugar	2.022	1.904	1.884	1.761	1.680	1.557	1.536	1.503	1.510	1.426
chocolate	0.147	0.141	0.142	0.142	0.141	0.141	0.151	0.235	0.243	0.250
confectionery	0.268	0.285	0.286	0.296	0.314	0.321	0.326	0.306	0.305	0.319
Coffee, tea and cocoa in kg, of which:	0.469	0.459	0.453	0.442	0.451	0.426	0.416	0.413	0.403	0.405
coffee	0.303	0.309	0.306	0.305	0.308	0.295	0.289	0.288	0.286	0.286
tea	0.143	0.137	0.123	0.128	0.127	0.121	0.107	0.107	0.103	0.104
Mineral and spring waters in l	4.815	4.798	4.882	5.539	6.406	6.328	6.439	6.429	6.484	7.235
Fruit and vegetable juices in l	1.699	1.571	1.540	1.507	1.459	1.324	1.167	1.173	1.201	1.267

Source: *own computation based on Table 1 and CSO materials: Household budget survey in 2006, (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015), Warsaw 2007: pp. 108–125; 2008: pp. 124–141; 2009: pp. 142–159; 2010: pp. 138–155; 2011: pp. 150–167; 2012: pp. 146–163; 2013: pp. 170–187; 2014: pp. 170–187; 2015: pp. 170–187.*

4. Assessment whether models fit the empirical data

The verification includes examining whether the theoretical values fit the given data and checking the significance of structural parameter assigned to the explanatory variable.

The coefficient of determination R^2 indicates how the model fits the empirical observations. It is a relative and dimensionless measure, so its value may be compared between certain food subcategories and years within assortment categories. Additionally, the coefficient of determination is a normalized ratio, therefore it is easy to judge whether its value is high or low. Table 3 shows results of the coefficient R^2 yielded for each of 450 models.

The coefficient of determination connected with the first linear causal-descriptive model is equal to 0.593. It means that 59.3% of the variation in *Y* was explained by the estimated model.

Thorough analysis of outcomes in Table 3 allows to state that a significant majority of causal-descriptive models fit the empirical data. That means, adopted analytical form of models describes well the variability of the dependent variable. There are, however, some exceptions which are the following assortment groups: bread, flour, milk, potatoes, beetroots and sugar (those items are in Table 3 in bold). For the mentioned six categories computed fit coefficient is below 0.5 within all the years or some of them. Hence, it should be stated that the linear function is not a good approximation describing the mean quantity of monthly consumption *per capita* of bread, flour, milk, potatoes, beetroots and sugar with respect to the household size and therefore a new more suitable function should be employed – a curvilinear one.

5. Testing significance of the structural parameter associated with the explanatory variable

Statistics t_1 for each out of 450 estimated models are shown in Table 4. At significance level of 0.1 and 4 degrees of freedom the critical value t_α in Student *t* distribution is 2.13. Comparing outcomes shown in Table 4 with the critical value allows for some conclusions:

- for bread, flour, milk, potatoes, beetroots and sugar (the said items are in bold) computed value of Student *t* statistic is in each year (or in some of the years under analysis) lower than t_α – thus structural parameter associated with the variable x_i in the linear regression model is insignificant;
- for remaining groups and subgroups of foodstuffs computed value of Student *t* statistic is higher than t_α in each year (or in most of ten years under consideration) what allows to deduce that structural parameter assigned to the variable x_i in the linear regression model is significantly different from zero.

6. Conclusions

Analysis of differences in consumed quantities of food and non-alcoholic beverages is an important research area because it is also related to the dispersion of living conditions in the whole population. Of course, the amount of consumed food is not the only – but still crucial – variable influencing the living standard of people in Poland.

Table 3

Coefficients R^2 for estimated models

	Years									
Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Bread and cereals in kg, of which:	0.593	0.659	0.628	0.620	0.637	0.668	0.671	0.674	0.655	0.700
rice	0.730	0.763	0.791	0.791	0.771	0.800	0.784	0.827	0.814	0.779
bread	*0.434*	*0.534*	*0.472*	*0.496*	*0.484*	*0.529*	*0.519*	*0.489*	*0.471*	*0.577*
pasta	0.821	0.820	0.822	0.816	0.820	0.840	0.838	0.846	0.848	0.849
flour	*0.338*	*0.453*	*0.420*	*0.281*	*0.388*	*0.423*	*0.475*	*0.472*	*0.332*	*0.369*
Meat in kg, of which:	0.832	0.846	0.835	0.829	0.829	0.824	0.833	0.848	0.824	0.820
raw meat	0.787	0.831	0.813	0.775	0.815	0.787	0.791	0.827	0.807	0.806
poultry	0.839	0.842	0.847	0.822	0.833	0.833	0.842	0.866	0.819	0.806
processed meat and other meat preparations	0.862	0.855	0.850	0.860	0.834	0.853	0.872	0.881	0.862	0.847
Fish and seafood in kg	0.888	0.891	0.898	0.892	0.909	0.882	0.876	0.852	0.852	0.867
Milk in l	*0.440*	*0.517*	*0.441*	*0.469*	*0.461*	*0.537*	*0.541*	*0.606*	*0.556*	*0.602*
Yogurt in kg	0.965	0.953	0.975	0.939	0.945	0.965	0.984	0.985	0.977	0.951
Cheese and curd in kg, of which:	0.949	0.950	0.953	0.948	0.948	0.962	0.968	0.946	0.941	0.926
curd	0.860	0.890	0.871	0.892	0.912	0.916	0.927	0.884	0.875	0.876
ripening and melted cheese	0.987	0.987	0.987	0.989	0.995	0.994	0.995	0.996	0.998	0.981
Cream in l	0.764	0.821	0.809	0.825	0.784	0.804	0.836	0.833	0.809	0.834
Eggs in units	0.793	0.804	0.784	0.789	0.758	0.781	0.783	0.793	0.782	0.776
Oils and other fats in kg, of which:	0.782	0.783	0.771	0.774	0.787	0.767	0.783	0.787	0.756	0.774
animal fats	0.824	0.831	0.816	0.836	0.841	0.803	0.810	0.825	0.842	0.854
butter	0.877	0.919	0.895	0.888	0.881	0.873	0.893	0.886	0.896	0.894
vegetable fats	0.747	0.733	0.698	0.718	0.736	0.736	0.758	0.752	0.682	0.699
Fruit, nuts and processed fruit in kg, of which:	0.891	0.902	0.908	0.888	0.893	0.910	0.889	0.900	0.892	0.909
fruit	0.884	0.896	0.902	0.882	0.885	0.904	0.883	0.895	0.887	0.903
citrus fruit and bananas	0.956	0.956	0.974	0.975	0.959	0.964	0.950	0.946	0.943	0.959
apples	0.808	0.803	0.796	0.786	0.802	0.813	0.765	0.789	0.789	0.807
berries	0.868	0.883	0.891	0.869	0.833	0.857	0.877	0.873	0.888	0.885
nuts and processed fruit	0.944	0.984	0.958	0.966	0.910	0.952	0.959	0.953	0.953	0.976

Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Vegetables, mushrooms, processed vegetables and mushrooms in kg, of which:	0.739	0.746	0.717	0.692	0.659	0.733	0.717	0.750	0.789	0.808
potatoes	*0.507*	*0.553*	*0.454*	*0.343*	*0.235*	*0.420*	*0.299*	*0.441*	*0.531*	*0.566*
other vegetables and mushrooms	0.829	0.824	0.820	0.803	0.804	0.826	0.834	0.821	0.840	0.865
cabbage	0.655	0.754	0.659	0.531	0.561	0.627	0.670	0.717	0.658	0.711
tomatoes	0.860	0.873	0.862	0.862	0.883	0.873	0.870	0.858	0.870	0.878
cucumbers	0.756	0.616	0.728	0.746	0.629	0.737	0.767	0.744	0.809	0.791
beetroots	*0.617*	*0.457*	*0.268*	*0.407*	*0.377*	*0.442*	*0.558*	*0.433*	*0.477*	*0.664*
carrots	0.717	0.720	0.741	0.695	0.687	0.716	0.724	0.708	0.744	0.787
processed vegetables and mushrooms	0.965	0.958	0.963	0.973	0.958	0.961	0.958	0.951	0.948	0.949
Sugar, jam, honey, chocolate and confectionery in kg, of which:	0.688	0.731	0.696	0.652	0.693	0.663	0.665	0.751	0.764	0.730
sugar	*0.558*	*0.597*	*0.548*	*0.458*	*0.490*	*0.461*	*0.457*	*0.494*	*0.491*	*0.463*
chocolate	0.865	0.903	0.910	0.910	0.910	0.903	0.878	0.908	0.954	0.944
confectionery	0.960	0.993	0.988	0.986	0.987	0.983	0.977	0.989	0.993	0.962
Coffee, tea and cocoa in kg, of which:	0.860	0.856	0.862	0.833	0.850	0.864	0.869	0.849	0.849	0.855
coffee	0.847	0.855	0.849	0.833	0.844	0.833	0.834	0.872	0.850	0.841
tea	0.803	0.857	0.789	0.817	0.816	0.903	0.827	0.829	0.894	0.899
Mineral and spring waters in l	0.987	0.987	0.993	0.986	0.993	0.980	0.975	0.984	0.968	0.989
Fruit and vegetable juices in l	0.916	0.871	0.807	0.864	0.874	0.869	0.827	0.839	0.832	0.802

Source: *own computation based on Table 1, Table 2 and GUS materials: Household budget survey in 2006, (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015), Warsaw 2007: pp. 108–125; 2008: pp. 124–141; 2009: pp. 142–159; 2010: pp. 138–155; 2011: pp. 150–167; 2012: pp. 146–163; 2013: pp. 170–187; 2014: pp. 170–187; 2015: pp. 170–187.*

Table 4

Test statistics t_1 for estimated models

	Years									
Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Bread and cereals in kg, of which:	2.41	2.78	2.60	2.56	2.65	2.84	2.86	2.88	2.75	3.06
rice	3.29	3.59	3.89	3.89	3.67	4.00	3.81	4.37	4.19	3.75
bread	*1.75*	*2.14*	*1.89*	*1.98*	*1.94*	*2.12*	*2.08*	*1.96*	*1.89*	*2.34*
pasta	4.28	4.27	4.30	4.21	4.27	4.57	4.54	4.69	4.72	4.73
flour	*1.43*	*1.82*	*1.70*	*1.25*	*1.59*	*1.71*	*1.90*	*1.89*	*1.41*	*1.53*
Meat in kg, of which:	4.45	4.69	4.50	4.40	4.41	4.33	4.47	4.72	4.32	4.27
raw meat	3.85	4.44	4.17	3.71	4.20	3.85	3.89	4.37	4.09	4.07
poultry	4.56	4.62	4.70	4.30	4.47	4.46	4.62	5.09	4.26	4.07
processed meat and other meat preparations	5.00	4.85	4.76	4.96	4.48	4.82	5.23	5.44	5.01	4.71
Fish and seafood in kg	5.62	5.70	5.95	5.75	6.31	5.46	5.32	4.80	4.80	5.10
Milk in l	*1.77*	*2.07*	*1.78*	*1.88*	*1.85*	*2.15*	*2.17*	*2.48*	*2.24*	*2.46*
Yogurt in kg	10.46	9.01	12.39	7.83	8.26	10.43	15.68	16.33	12.99	8.85
Cheese and curd in kg, of which:	8.61	8.72	8.97	8.51	8.51	10.02	10.99	8.35	7.97	7.06
curd	4.95	5.68	5.20	5.74	6.43	6.60	7.15	5.51	5.30	5.32
ripening and melted cheese	17.35	17.13	17.65	19.17	27.62	25.22	27.01	30.80	40.94	14.41
Cream in l	3.60	4.29	4.11	4.35	3.81	4.05	4.52	4.46	4.11	4.49
Eggs in units	3.91	4.05	3.81	3.86	3.54	3.78	3.80	3.92	3.79	3.73
Oils and other fats in kg, of which:	3.79	3.80	3.67	3.70	3.84	3.63	3.80	3.84	3.52	3.70
animal fats	4.33	4.44	4.21	4.52	4.60	4.04	4.13	4.34	4.62	4.84
butter	5.33	6.73	5.83	5.64	5.45	5.23	5.77	5.57	5.87	5.82
vegetable fats	3.44	3.31	3.04	3.19	3.34	3.34	3.54	3.49	2.93	3.05
Fruit, nuts and processed fruit in kg, of which:	5.73	6.08	6.29	5.64	5.78	6.36	5.65	5.99	5.76	6.31
fruit	5.53	5.87	6.07	5.46	5.54	6.14	5.50	5.83	5.61	6.10
citrus fruit and bananas	9.34	9.33	12.32	12.57	9.66	10.34	8.74	8.39	8.12	9.66
apples	4.10	4.04	3.95	3.84	4.02	4.18	3.60	3.87	3.87	4.08
berries	5.14	5.50	5.72	5.15	4.47	4.90	5.35	5.25	5.62	5.53
nuts and processed fruit	8.19	15.76	9.54	10.59	6.34	8.95	9.70	8.97	8.98	12.72

Foodstuffs:	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Vegetables, mushrooms, processed vegetables and mushrooms in kg, of which:	3.36	3.43	3.18	3.00	2.78	3.32	3.18	3.47	3.86	4.11
potatoes	*2.03*	*2.22*	*1.82*	*1.44*	*1.11*	*1.70*	*1.31*	*1.78*	*2.13*	*2.28*
other vegetables and mushrooms	4.41	4.33	4.27	4.04	4.04	4.36	4.49	4.28	4.57	5.07
cabbage	2.76	3.50	2.78	2.13	2.26	2.59	2.85	3.19	2.77	3.14
tomatoes	4.97	5.25	5.00	5.00	5.49	5.24	5.17	4.93	5.16	5.36
cucumbers	3.52	2.53	3.27	3.43	2.60	3.35	3.63	3.41	4.12	3.89
beetroots	*2.54*	*1.83*	*1.21*	*1.66*	*1.55*	*1.78*	*2.25*	*1.75*	*1.91*	*2.81*
carrots	3.18	3.21	3.39	3.02	2.96	3.18	3.24	3.11	3.41	3.84
processed vegetables and mushrooms	10.48	9.52	10.26	12.07	9.53	9.98	9.58	8.80	8.55	8.60
Sugar, jam, honey, chocolate and confectionery in kg, of which:	2.97	3.30	3.02	2.74	3.01	2.81	2.82	3.48	3.60	3.29
sugar	*2.25*	*2.43*	*2.20*	*1.84*	*1.96*	*1.85*	*1.84*	*1.98*	*1.97*	*1.86*
chocolate	5.06	6.12	6.35	6.35	6.34	6.10	5.35	6.28	9.06	8.17
confectionery	9.84	23.77	17.84	16.54	17.37	15.38	12.94	18.87	23.63	10.10
Coffee, tea and cocoa in kg, of which:	4.96	4.88	4.99	4.47	4.76	5.03	5.14	4.75	4.73	4.86
coffee	4.71	4.86	4.74	4.46	4.66	4.47	4.49	5.23	4.75	4.60
tea	4.04	4.90	3.87	4.22	4.21	6.10	4.37	4.40	5.80	5.96
Mineral and spring waters in l	17.26	17.42	23.21	16.70	23.42	13.89	12.59	15.88	11.06	19.32
Fruit and vegetable juices in l	6.61	5.20	4.09	5.05	5.28	5.15	4.37	4.57	4.44	4.03

Source: *own computation based on Table 1, Table 2 and GUS materials: Household budget survey in 2006, (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015), Warsaw 2007: pp. 108–125; 2008: pp. 124–141; 2009: pp. 142–159; 2010: pp. 138–155; 2011: pp. 150–167; 2012: pp. 146–163; 2013: pp. 170–187; 2014: pp. 170–187; 2015: pp. 170–187.*

The purpose of this article was to seek the stochastic relationship between the consumption *per capita* of 45 food categories and the number of people forming a household, and then dividing the food products into two separate groups: the ones with linear relationship and those with nonlinear relationship.

The article tested the research hypothesis that the linear function is a good approximation to describe the relationship between the mean monthly consumption *per capita* and the household size for most assortment groups under analysis. For 39 out of 45 categories of food the estimated econometric model fitted well the empirical data and the independent variable affected significantly the dependent variable, thus it may be stated that the linear function is a good approximation here. **It can be said that in the case of these 39 assortment groups the increase in household size by one person causes the decrease in consumption *per capita* by approximately constant amount regardless whether the household size increases from one to two, from two to three, from three to four etc. This assertion is not obvious and – from the scientific point of view – rather surprising. The fact constitutes a high cognitive value of this article.** For remaining 6 categories (namely: bread, flour, milk, potato, beetroots and sugar) out of 45 should be sought other (i.e. nonlinear) model.

Additionally, two auxiliary hypotheses were formulated. The first one, structural parameters a_0 and a_1 of the regression model are relatively stable throughout the time from 2006 to 2015 for each food category / subcategory considered. The said hypothesis was verified positively by comparing parameter a_0 (parameter a_1) from 2006 to 2015. It was confirmed that outcomes in each line in Table 2 (each line in Table 1) are similar.

The second tested auxiliary hypothesis stated that an increase in the size of household results in a decrease in consumed amounts *per capita* for each assortment group investigated. It was verified positively due to the fact that the parameter a_1 in all of 450 linear causal-descriptive models was negative.

The conclusions drawn in this article may be further examined. In particular, it would be worth seeking another nonlinear function to describe better the relationship between the consumption of bread, flour, milk, potatoes, beetroots and sugar and the size of household. Detailed analysis of 60 scatter diagrams (6 assortment items $\times$ 10 years) enables to ascertain that a fourth-degree polynomial would be the appropriate model here. It is mainly because of the presence of three turning points (two maxima and one minimum) and two inflexion points in the said graphs. Where a fourth-degree polynomial had a turning point, its first-order derivative would be zero[1]. The first-order derivative of a fourth-degree polynomial is a third-degree polynomial which can have three roots[2]. Where a fourth-degree polynomial had inflexion points, its second-order derivative would be zero[3]. The second-order derivative of fourth-degree

[1] If a differentiable function $f(x)$ has a local turning point at x_0, then $f'(x_0) = 0$.

[2] A *k*-degree polynomial has no more than *k* roots. Cf. Matłoka M., Wojcieszyn B., *Matematyka z elementami zastosowań w ekonomii* [*Mathematics with elements of applications in economics*], WSB, Poznań 2008, p. 51.

[3] If a function f is continuous and twice differentiable at x_0 and $(x_0, f(x_0))$ is an inflexion point of the f graph, then $f''(x_0) = 0$.

polynomial is a second-degree polynomial that may have two roots. It means that due to the necessity of getting three turning points with two inflexion points, there is no need to employ any higher polynomial that quartic. But further research in the said scope goes beyond the aim of this article.

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ԱՆՆԱ ՏՈՒՐՉԱԿ
Լեհաստանի Շչեցինա քաղաքի Արևմտապոմերանյան բիզնեսի բարձրագույն դպրոցի տնտեսագիտության և ինֆորմատիկայի ֆակուլտետի պրոֆեսորի ասիստենտ

Սննդամթերքի սպառումը՝ պայմանավորված տնային տնտեսության մեծությամբ.– Հոդվածը ներկայացնում է գծային պատճառական–նկարագրական մոդելների կառուցվածքային պարամետրերը ապրանքային տեսականու 45 խմբի պարագայում: Հաշվարկը կատարվել է 2006–2015 թթ. ժամանակահատվածի համար՝ ըստ Լեհաստանի կենտրոնական վիճակագրական վարչության տրամադրած տվյալների: Մոդելները հաստատվել են՝ հաշվի առնելով համապատասխան տեսական արժեքները և ստուգելով անկախ փոփոխականների հետ կապված կառուցվածքային պարամետրերի նշանակությունը: Արդյունքում սահմանվել են սննդային կարգեր, որոնց դեպքում գծային ֆունկցիան մեկ շնչին բաժին ընկնող սպառման և տնային տնտեսության մեծության միջև գոյություն ունեցող ստոխաստիկ հարաբերությունը նկարագրող մոտեցում է, որը կարող է կիրառվել նաև այնպիսի սննդամթերքի պարագայում, որի հարաբերությունը ոչ գծային է: Առաջին խմբում 45 տեսականուց 39-ն են ընդգրկված, իսկ երկրորդում՝ միայն 6-ը, մասնավորապես՝ հաց, ալյուր, կաթ, կարտոֆիլ, ճակնդեղ և շաքարավազ:

Հիմնաբառեր. *սննդի սպառում, տնային տնտեսության չափ, գծային պատճառական–նկարագրական մոդել, ռեգրեսիոն մոդել, տնտեսաչափական մոդելի հաստատում:*
JEL: C51, C52, D1, D12

АННА ТУРЧАК
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Потребление продовольственных товаров в зависимости от размеров домашнего хозяйства.– Статья представляет структурные параметры линейных причинно–описательных моделей для 45-ти групп ассортимента. Расчёт был произведён по годам в промежутке с 2006–2015 гг. и был основан на данных, предоставленных Центральным статистическим управлением Польши.

Модели подтверждены с учётом оценки соответствующих теоретических значений и проверки значения структурного параметра, связанного с независимой переменной. В итоге были определены категории продуктов, для которых линейная функция является хорошей апроксимацией, описывающей стокартическое соотношение между потреблением на душу населения и размером домашнего хозяйства, а также для таких продуктов, для которых соотношение является нелинейным. Первая группа состоит из 39

от 45 общего числа групп ассортимента, а вторая включает только 6, в частности: хлеб, муку, молоко, картофель, свёклу и сахарный песок.

Ключевые слова: *потребление продовольственных товаров, размер домашнего хозяйства, линейная причинно–описательная модель, регрессивная модель, подтверждение экономической модели.*
JEL: C51, C52, D1, D12