Food expenditures of Czech households and Engel's Law

Výdaje za potraviny českých domácností a Engelův zákon

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Abstract: The paper is focused on the analysis of Engel's Law validity within food expenditures of Czech households. The realised research dealt with the impacts of real income sizes of the average Czech household on its real shares of food expenditures in 1995–2002. The evaluation of Engel's Law validity was based on the regression demand model with the regressor – real income and the regressant – real food share. Because the Czech Statistical Office database had a time dimension, the research was firstly devoted to the time-series analysis of the used database. The trend and periodical components of both time-series were quantified by the means of the decomposition non-adaptive approach with a proportional form of additive model. Under determination of time systematic components of both time-series, time-free residues could be computed and used for the creation of the stationary demand model. The realised analysis verified the validity of Engel's Law in the field of food expenditures of the average Czech household. Thus the real shares of food expenditures fell under the increase rate of the real households' incomes. This fact was represented by the negative value of the model parameter β (-4.4138×10^{-6}). According to the estimated value of β, the rise of the real income of the average Czech household by 1 CZK implies the fall of the real food expenditure share by 4.4138×10^{-6}%.

Key words: food expenditures, time development of real incomes and food shares, stationary share model of demand, Engel's Law

Abstrakt: Příspěvek je věnován výzkumu fungování Engelova zákona při nákupu potravin u českých domácností. V rámci prováděného výzkumu byla hodnocena závislost mezi velikostí reálného příjmu průměrné české domácnosti a jejího reálného podílu výdajů vynaloženého za potraviny. Hodnocení Enegelova zákona v této oblasti bylo postaveno na regresním modelu poptávky, jehož závislou proměnou byl reálný podíl výdajů za potraviny a nezávislou proměnnou reálný příjem. Jelikož databáze získaná z ČSÚ měla formu časový řad, byl nejprve výzkum soustředěn na analýzu systematické časové složky. Na základě dekompozičního neadaptivního konceptu s aditivním tvarem modelu byla popsána trendová a periodická složka vývoje v používané datové základně. Její znalost byla využita k určení času prostých reziduí, na jejíž základě byl sestaven výše zmíněný poptávkový model. Analýzou závislostí mezi výší reálného příjmu průměrné české domácnosti a velikostí jejich reálně vyjádřeného podílu výdajů věnovaného na nákup potravin byla potvrzena platnost Engelova zákona. Tedy s rostoucím reálným příjmem u dané domácnosti klesal podíl jejich reálných výdajů vynaložených na potraviny, což ve vytvořeném časově stacionarizovaném modelu poptávky vyjadřovala záporná směrnice: $-4{,}4138 \times 10^{-6}$. Marginálně lze zjištěnou závislost popsat takto: zvýšení reálného příjmu průměrné české domácnosti o 1 Kč vyvolá pokles reálně vyjádřeného podílu výdajů za potraviny u této domácnosti o $4{,}4318 \times 10^{-6}$ %. Dosažený výsledek je možné považovat za statisticky signifikantní, protože *T*-test daného regresního koeficientu dosáhl hladinu významnosti a rovnu $3{,}5636 \times 10^{-2}$.

Klíčová slova: výdaje za potraviny, časový vývoj reálných příjmů a výdajů, stacionarizovaný poptávkový model, Engelův zákon

INTRODUCTION

Food expenditures occupy an important position in the structure of consumption baskets of Czech households as it is documented by their levels in relation to the sizes of households' incomes in 1995–2002. For the average Czech household in this time period, the real shares[1] of food expenditures moved between the value of 22.7% and 21.3%. The time development of these shares is depicted in Figure 1.

Figure 1 shows that the real shares of food expenditures have more or less a falling tendency for the aver-

This contribution has been developed within the solution of the grant research project of the GACR 402/02/P056 "Research of Consumers Behaviour on the Food Markets in the Czech Republic", which is linked to the research project of the FBE MUAF Brno, MSMT 431100007 "Forming of the Structure of Agriculture and Food industry and Trends in Behaviour of Entrepreneurial Subjects within Process of Czech Republic Integration into the EU".

[1] The real food share was measured in the prices of 1995.

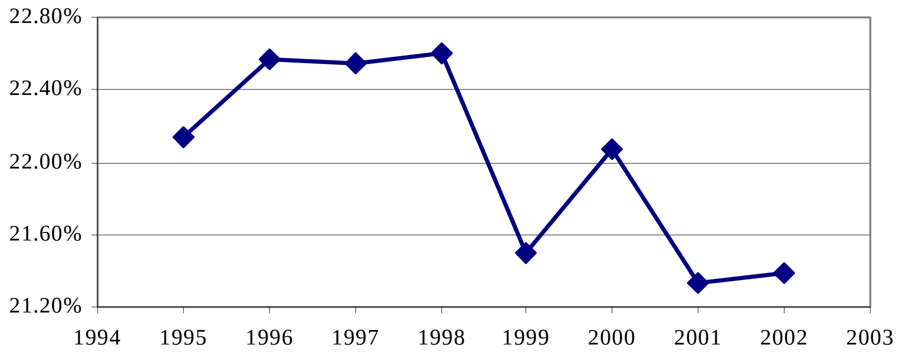

Figure 1. The development of real year shares of food expenditures of the average Czech household

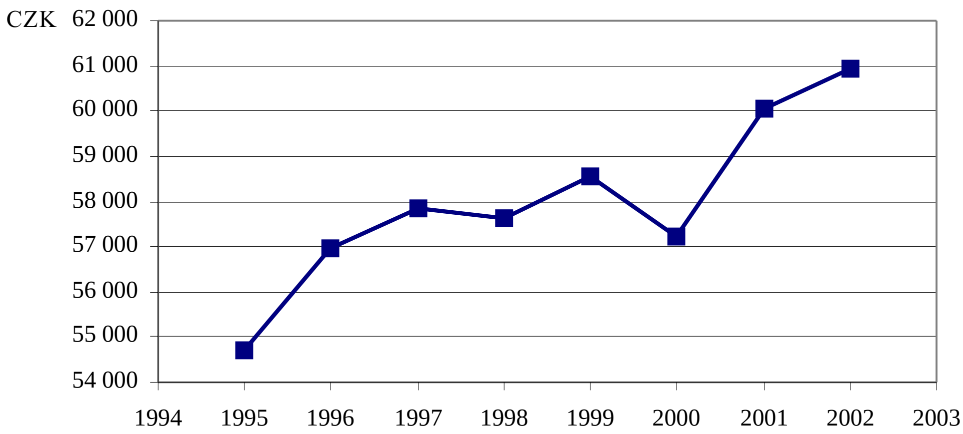

Figure 2. The development of real year incomes of the average Czech household

age Czech household in the observed period. This decrease of the real food shares can be explained in relation to the development of the households' incomes (Figure 2). According to the Engel's Law[2], the share of food expenditures decreases with the increase of household's incomes. On the contrary, the shares of the education, travel or similar expenditures increase with the rise of the households' incomes (Loeb 1955). According to Ernest Engel, the size of the food expenditure share can be used as a welfare indicator (Zimmerman 1932).

MATERIAL

The validity of the Engel's Law on the food purchases of Czech households was tested on the average Czech household data. There was used the database of the Czech Statistical Office (CSO). This database provided the quarterly levels of the total food expenditures[3] (*e*) and the total incomes (*m*) of the average Czech household from 1995 to 2002. These nominal data are available in the publication "Labour, Social Statistics: Series No. 30 – Living Costs". For the elimination of the prices impacts on the investigated Engel patterns (Maurice, Phillips 1992), the original nominal data were transformed into their real level. The real levels[4] of food expenditures (*re*) were calculated by the following formula:

$$re = \frac{e}{CPI_f} \tag{1.1}$$

and the real sizes of household's incomes (*rm*) were computed using the following formula:

$$rm = \frac{m}{CPI} \tag{1.2}$$

[2] German statistician and economist who developed the empirical law in the field of consumption. Engel (1821–1896) devoted his works to the income impacts on household consumption. The income- demand function is named after him.

[3] The composition of total food expenditures according to the CSO evidence: meat and meat products + fish and fish products + fat and oils + eggs, milk and cheeses + bread and bakers' products + potatoes and vegetables + fruits and fruit products + sugar and sweets + cocoa, coffee, tea and other foods.

[4] From the terminological point of view, the real food expenditures represent the expenditures with fixed price level (price level of selected basic year).

Table 1. Real year incomes and food expenditures of the average Czech household

Years	Real food expenditures (CZK), *re*				Real incomes (CZK), *rm*			
	I Q	II Q	III Q	IV Q	I Q	II Q	III Q	IV Q
1995	2 795	2 992	3 032	3 288	12 482	13 153	14 088	14 977
1996	2 965	3 141	3 257	3 493	13 392	14 522	13 877	15 181
1997	3 093	3 193	3 260	3 492	13 926	14 903	14 058	14 939
1998	2 992	3 195	3 256	3 582	13 873	14 319	14 177	15 271
1999	2 949	3 075	3 162	3 399	13 871	14 810	14 605	15 269
2000	2 970	3 163	3 144	3 348	13 206	14 617	14 117	15 273
2001	2 985	3 176	3 170	3 481	14 278	15 133	14 615	16 033
2002	3 050	3 155	3 287	3 536	14 348	15 294	15 111	16 166

Source: CSO

Table 2. Real share of food expenditures of the averege Czech household

Years	Real food shares: *rw* (%)			
	I Q	II Q	III Q	IV Q
1995	22.39	22.75	21.52	21.95
1996	22.14	21.63	23.47	23.01
1997	22.21	21.42	23.19	23.37
1998	21.57	22.31	22.97	23.46
1999	21.26	20.76	21.65	22.26
2000	22.49	21.64	22.27	21.92
2001	20.91	20.99	21.69	21.71
2002	21.26	20.63	21.76	21.87

For the calculation of the real expenditures within a given quarter of the studied years, the denominator of the fraction (1.1) was determined as the geometric mean of the basic month indexes of the consumer prices of food, beverages and tobacco products (CPI_f). The month basic CPI_f (January 1995 = 100%) were calculated from their chain form, which is registered in the publication " Prices, series No. 71 – Consumer Prices". The real levels of the incomes of the average Czech household were assessed analogically, but there was used the total index of consumer prices of all goods in the consumer basket (*CPI*) of the average Czech household. The acquired real levels of the quarterly food expenditures and incomes are displayed in Table 1.

From the values in Table 1, the real food shares were achieved using the the formula (2):

$$rw = \frac{re}{rm} \tag{2}$$

These values by formula (2) are summarised for the individual quarter term of 1995–2002 in Table 2.

METHODS OF RESEARCH

The validity of the Engel's Law on the food expenditures of the average Czech household was studied by means of the share demand model with the income explanatory variable:

$$rw = f\,(rm, u) \tag{3}$$

rw the real quarterly proportion of the food expenditure to the total household income of the average Czech household
rm the real quarterly income of the average Czech household
u random (stochastic) variable

Because the used database had a time dimension (time-series data), the existence of systematic development of both time series *rw*, *rm* was firstly investigated, so that the fictitious regression (induced by time factor) could be eliminated (Hušek 1932). The non-adaptive decomposition approach with the model in additive form was chosen for the time-series analysis of *rw* and *rm* (Minařík 1998). Thus, the total levels of the studied events *rw* and *rm* in the relevant time period were defined as the sum of systematic (*SS*) and non-systematic (ε) component. At the point, the systematic component of the analysed development was represented by the sum of the trend (*TS*) and periodical (*PS*) component. For the real shares of the food expenditures, the time-series model was formalised as (4.1):

$$rw = SS1 + \varepsilon 1 = (TS1 + PS1) + \varepsilon 1 \tag{4.1}$$

The time-series model for real incomes was formally put (4.2):

$$rm = SS2 + \varepsilon 2 = (TS2 + PS1) + \varepsilon 2 \tag{4.2}$$

In the initial stages of the time-series research of *rw* and *rm*, the trend was evaluated. According to the visual apprise, the trend component of the real shares of the food expenditures was described by the linear regression function:

$$TS1_t = a1 + b1 \times t \tag{5.1}$$

Likewise, the linear form of the regression function was used in the case of time-series of the real incomes:

$$TS2_t = a2 + b2 \times t \tag{5.2}$$

Time variable (t) in the trend model (5.1) and (5.2) was declared consequently (6):

$t = 1$ I Q 1995

$t = 2$ II Q 1995

....

$t = 3$ IVQ 2002 (6)

The estimation of the regression parameters of both trend straight lines (5.1), (5.2) was based on the method of the ordinary least squares. Basic statistic verification of these trend models was evaluated by means of the determination coefficients ($r1^2$), ($r2^2$) and by means of F-tests: ($F1$), ($F2$). The significance levels of F-tests: ($\alpha 1$), ($\alpha 2$) were also used for the evaluation of significance levels T-tests of regression coefficients: (T_{b1}) a (T_{b2}), because the levels of the mentioned tests are equal in the case of one-factor regression models (Zvára 1989). T-tests: (T_{a1}), (T_{a2}) were naturally used for the investigation of the significance levels of absolute members of linear trend models: ($\alpha 1$), ($\alpha 2$).

In the relation to the results of the linear trend analysis, the periodical component of both time-series was studied too. Fourier's harmonic analysis, especially the construction of periodograms, was used for the detection and statistic verification of the periodical oscillation in the investigated time-series. The extremes of the developed periodograms were statistically tested by means of G-statistics: ($G1$), ($G2$). This method is precisely described in the publication of Seger, Hindls, Hronová 1998. After the identification of the length of the periodical wave[5] (l), respective their number (n) in the observed time period, their intensity was quantified. The intensity of periodical oscillation was measured on the base of the proportional concept, thus by the values of the periodical indexes. For the real shares of the food expenditures, the time-series model with proportional periodical component had formalised form (7.1):

$$rw_{ij} = TS1_{ij} + c1_j \times TS1_{ij} + \varepsilon 1_{ij} = (1 + c1_j) \times TS1_{ij} + \varepsilon 1_{ij} \quad (7.1)$$

The same time-series model for real incomes was formally described (7.2):

$$rm_{ij} = TS2_{ij} + c2_j \times TS2_{ij} + \varepsilon 2_{ij} = (1 + c2_j) \times TS2_{ij} + \varepsilon 2_{ij} \quad (7.2)$$

The above introduced model concepts (7.1) and (7.2) imply the need of transformation of the original definition of the time variable in form (6) into the form (8):

$t = 1$ $i = 1,\ j = 1$ I Q 1995

$t = 2$ $i = 1,\ j = 2$ II Q 1995

....

$t = 32$ $i = n,\ j = 32/n$ IV Q 2002 (8)

In this new declaration of time variable (8), i describes the order of periodical wave, and j denotes partial phases within the periodical wave i. The values of periodical indexes for the time-series of real shares of food expenditures were computed by the following formula (9.1):

$$(1 + c1_j) = \frac{\sum_{i=1}^{n} rw_{ij} \times TS1_{ij}}{\sum_{i=1}^{n} TS1_{ij}^2} \qquad (j = 1..., 32/n) \quad (9.1)$$

For real incomes, the values of periodical indexes were achieved by the following formula (9.2):

$$(1 + c2_j) = \frac{\sum_{i=1}^{n} rm_{ij} \times TS2_{ij}}{\sum_{i=1}^{n} TS2_{ij}^2} \qquad (j = 1..., 32/n) \quad (9.2)$$

After the quantification of periodical indexes, the total systematic component was computed for both studied time-series. For the quarter real shares of food expenditures, the levels of the total systematic component were determined according to the model concept (7.1) with the declaration of time variable (8):

$$SS1_{ij} = TS1_{ij} + c1_j \times TS1_{ij} = (1 + c1_j) \times TS1_{ij} = (1 + c1_j) \times (a1 + b1 \times t) \quad (10.1)$$

The levels of the total systematic component of the quarter real incomes were analogically achieved on the base of model concept (7.2) with the declaration of time variable (8):

$$SS2_{ij} = TS2_{ij} + c2_j \times TS2_{ij} = (1 + c2_j) \times TS2_{ij} = (1 + c2_j) \times (a2 + b2 \times t) \quad (10.2)$$

After implementation of time-series models (10.1) and (10.2), the core of the planned research, i.e. the research of the validity of the Engel's Law on the food expenditures of the Czech households, could be started in full, thus. This research was based on the modified form of the above mentioned demand model (3):

$$\varepsilon 1ij = f(\varepsilon 2_{ij}, u_{ij}) \quad (11)$$

Thus, Engel's food expenditure patterns were investigated on the base of the regression analysis of non-systematic component of real shares:

$$\varepsilon 1_{ij} = rw_{ij} - SS1_{ij} \quad (12.1)$$

and non-systematic component of real incomes:

$$\varepsilon 2_{ij} = rm_{ij} - SS2_{ij} \quad (12.2)$$

The transformation of the regression model (3) into the form (11) was pursued by the elimination of the fictitious regression induced by the time factor. Straight line[6] was selected as the regression function:

$$\varepsilon 1_{ij} = \beta \times \varepsilon 2_{ij} + u_{ij} \quad (13)$$

The linear regression can be considered as an appropriate approximation of the researched relations in the

[5] The identification of two or more statistical signification periods can be explained by means of the composition periodical component (Seger, Hindls, Hronová 1998).

consumer demand, because the changes of the size of the real households' incomes in 1995–2002 were relatively small. Besides, the choice of the regression function was also subordinated to the value range of the residues $\varepsilon 1_{ij}$ and $\varepsilon 2_{ij}$:

$$\varepsilon 1_{ij}, \varepsilon 2_{ij} \in R \quad (14)$$

The value of regression parameters (β) in the model (13) was estimated by means of the method of the ordinary least squares. The basic statistical verification was led (Dufek 1993) through the value of the determination coefficient (ρ^2). Indirect statistical verification of the developed model (13) was accomplished (realised) by F-test of ρ^2. Because the studied demand function (13) was constructed as a one-factor regression model (two-variable regression problem), it was possible to assess the significance level of T-test of the regression parameter β (α_β) on the base of the reached significance level (α) of the F-test (Zvára 1989).

The application of the linear demand model (13) for the realised research in the field of food expenditures of Czech households and the validity of the Engel's Law was very easy. The application was based on the evaluation of the regression coefficient β. The negative value of β in the model:

$$\beta < 0 \quad (15)$$

represents the decrease of the real shares of food expenditures with the rise of the real households' incomes, thus the Engel's Law governs the food expenditures of Czech households.

RESULTS AND DISCUSSION

According to the above described methodology, the research of the validity of the Engel's Law in the field of food expenditures of the average Czech household began with the decomposition analysis of the systematic development of both studied time-series. At first, the trend component of the time-series of the real shares of food expenditures (*rw*) and the real incomes (*rm*) was investigated under the linear model concepts (5.1) and (5.2) with time declaration (6). The parameters and the statistical diagnostics are listed in Table 3 and Table 4.

The values in the Tables 3 and 4 imply, that the trends of the analysed time-series have not strength manifestations. In both cases, the determination coefficients ($r1^2$) and ($r2^2$) did not exceed the level 0.35. With respect to the results of $F1$-test and $F2$-test, respective T_{b1}-test and T_{b2}-test (statistical significance of the tests is higher than 95%), it is possible to work with the trend component at the next stages of this research. Moreover, the determination of the trend component is necessary for the exact results of the periodical analysis. The exactitude of the periodical analysis could be affected in the area of identification of periodical oscillation (wave length and frequency – harmonic analysis, periodogram) and in the area of the measurement of the regular oscillation intensity (periodical indexes – proportional model of periodicity).

The periodical analysis was realised after finishing the trend analysis. For both time-series, the periodograms were completed on the base of Fourier's harmonic analysis. The created periodograms were used for the identification of the number and length of the periodical cycles of the investigated time-series in the observed years. The results of the real shares of food expenditures of the average Czech household are graphically presented in Figure 3.

Figure 3 pointed clearly to the fact that the year period appears in the development of the real shares of the food expenditures of the average Czech household:

$$l = 4 \quad (16)$$

Table 3. Trend component – real shares of food expenditures of the average Czech household

Linear trend function: $TS1_t = a1 + b1 \times t$			
The values of regression parameters and determination coefficient	$a1 = 0.2263$	$b1 = -3.7281 \times 10^{-4}$	$r1^2 = 0.2003$
The values of T-test and F-test	$\lvert T_{a1} \rvert = 87.9895$	$\lvert T_{b1} \rvert = 2.7408$	$F1(1.30) = 7.5121$
Significance levels of T-test a F-test	$a_{Ta1} = 9.1043 \times 10^{-38}$	$a_{Tb1} = 1.0225 \times 10^{-2}$	$a1 = 1.0225 \times 10^{-2}$

Table 4. Trend component – real incomes of the average Czech household

Linear trend function: $TS2_t = a2 + b2 \times t$			
The values of regression parameters and determination coefficient	$a2 = 13\,676.0484$	$b2 = 49.7124$	$r2^2 = 0.3288$
The values of T-test and F-test	$\lvert T_{a2} \rvert = 55.7795$	$\lvert T_{b2} \rvert = 3.8337$	$F2(1.30) = 14.6972$
Significance levels of T-test a F-test	$a_{\lvert Ta2 \rvert} = 7.2742 \times 10^{-32}$	$a_{\lvert Tb2 \rvert} = 6.0182 \times 10^{-4}$	$a2 = 6.0182 \times 10^{-4}$

[6]The method of the least squares and the technique of the determination of time-free residues are given by the zero level of the absolute member of the regression linear function.

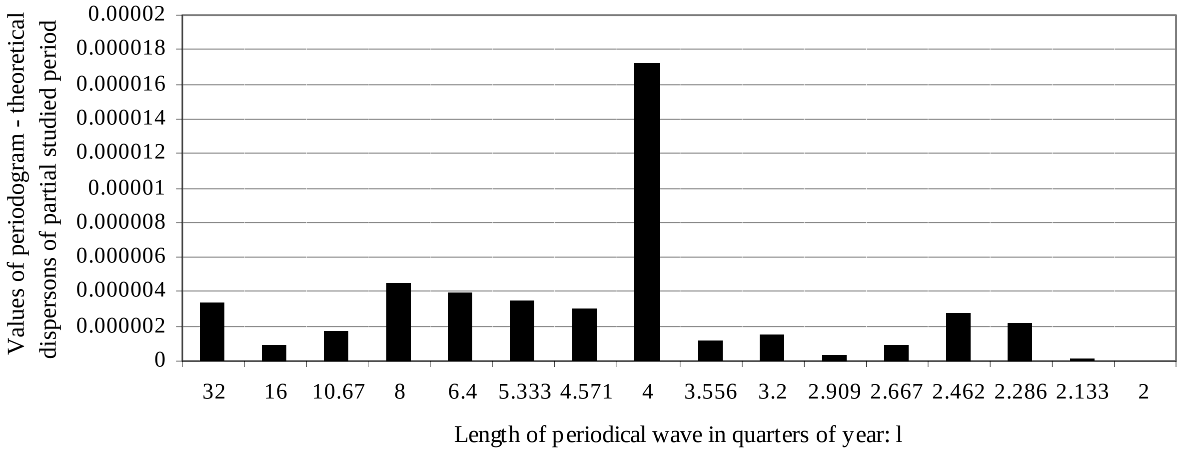

Figure 3. Periodogram – real shares of food expenditures of the average Czech household

With these regular year cycles within the real food shares, it is possible to term the seasonal oscillation. In the observed time period (1995–2002), there are 8 such seasons:

$$n = 8 \tag{17}$$

This detected year period of *rw* time-series (the extreme of periodogram) was examined by means of the *G*-test on the statistical significance. Based on the result of the *G*-test, it was found out that the detected season period is statistically significant on almost 99% level (significance level of *G*-test 1.8946%). With respect to the compound period of the *rw* time-series, two-year period was also tested similarly:

$$l = 8 \tag{18}$$

However, the second highest extreme of the constructed periodogram (Figure 3) was not statistically significant by the *G*-test, because the significance level of the realised test did not reach 10%.

The results of Fourier's harmonic analysis in the field of real incomes of the average Czech household are displayed in the following figure (Figure 4).

In Figure 4, the half-year period is extended from other theoretical possible periods in the constructed periodogram of the *rm* time-series:

$$l = 2 \tag{19}$$

Then in the observed time period (1995–2002), it is possible to define 16 such regular oscillations:

$$n = 16 \tag{20}$$

This detected extreme of the periodogram was statistically verified on the base of the *G*-test. The result of *G*-test indicated the 99.9% statistical significance of the half-year periods. With respect to the possible existence

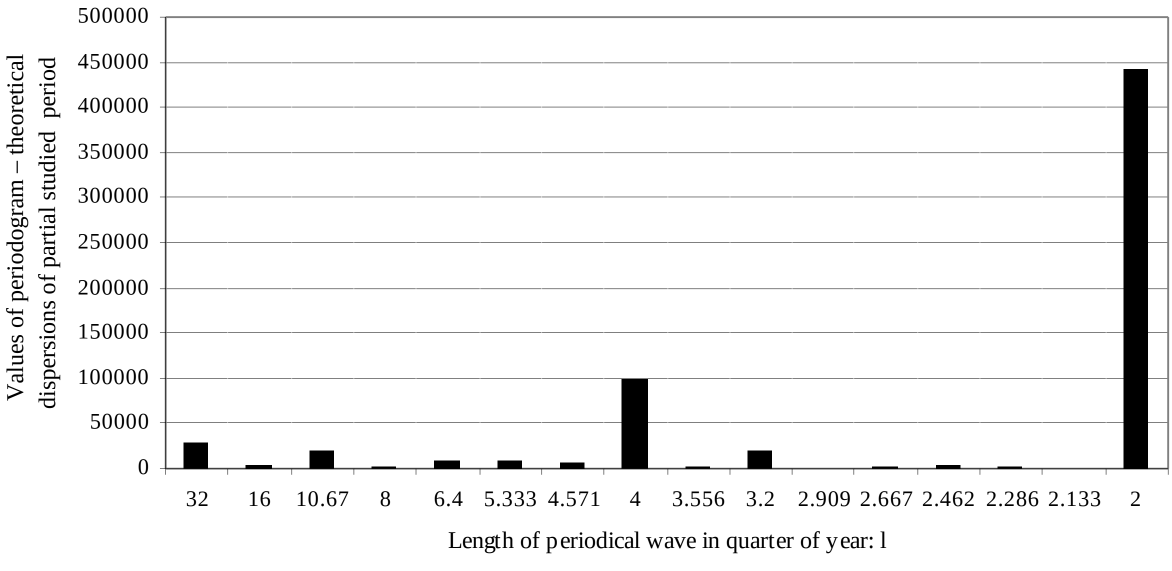

Figure 4. Periodogram – real incomes of the average Czech household

of the composed periods of the real incomes time-series, the year period was examined consecutively too:

$$l = 4 \quad (21)$$

However, the second highest extreme of the completed periodogram (Figure 4) was not statistically significant, because the significance level of realised *G*-test did not reach the value of 10%.

Measuring the oscillation intensity finished the periodical analysis of both time-series. The values of the seasonal indexes for the real shares of food expenditures were computed on the base of the adjusted formula (9.1) by achieved results (16) and (17). For the real incomes, the values of the indexes of half-year period were determined using the formula (9.2) with the adjustment (19), (20). The obtained values of these indexes are depicted in Table 5 and Table 6.

The indexes results (see Table5 and Table 6) demonstrate that the regular oscillation of both time-series is not of such an intensive character. For the time-series of the real share of food incomes (*rw*), the value of seasonal indexes ranged between –2.33% and +2.22%. These maximal levels of the indexes were validated only for the second and fourth quarters of the year. In other quarters, the values of seasonal indexes were measured on fewer levels, the first quarter of year had the level of –1.32% and the third quarter of year achieved +1.45%. For the time-series of the real incomes, the measure of regular oscillation was slightly more intensive. The indexes of the half-year period reached –3.26% (the odd quarters of the year) and other side +3.26% (the even quarters of the year). The description of periodical intensity implied the shape of oscillations. For *rw* time-series, the oscillations were below the trend line in the first and second quarters of the year. In the third and fourth quarters of the year, the studied regular oscillations moved above the level of the trend line. For *rm* time-series, the oscillation in odd quarters of year appeared below the line of trend. Vice versa, the oscillations of *rm* in even quarters of the year were above the trend line.

After the realisation of the complete periodical analysis, the total systematic component of both studied time-series could be consequently finished. The total systematic development of the real shares of food expenditures in 1995–2002 was simulated by the time regression model (10.1). Analogically, the estimates of total systematic components of the real incomes in 1995–2002 were based on the time model (10.2). Results in the fields are included in Table 7.

The quantification of the total systematic component of both time-series allowed the undistorted research of the validity of the Engel's Law in the area of food expenditures of Czech households. Firstly, the time-free residues were calculated in accord with the defined formulas (12.1) and (12.2). The values of the time-free residues are displayed in Table 8.

The linear regression model in form (13) was developed on the base of the residues in Table 8. This created mo-

Table 5. Periodical indexes – real share of food expenditures of the average Czech household

Quarter of year	Identification of partial term within each period (j)	Value of periodical indexes ($1 + c_j$)
I Q	$j = 1$	0.9868
II Q	$j = 2$	0.9767
III Q	$j = 3$	1.0143
IV Q	$j = 4$	1.0222

Table 6. Periodical indexes – real incomes of the average Czech household

Quarter of year	Identification of partial term within each period (j)	Value of periodical indexes ($1 + c_j$)
I Q and III Q	$j = 1$	0.9674
II Q and IV Q	$j = 2$	1.0326

Table 7. Total systematic components of development of real food share (*rw*) and real incomes (*rm*) of the average Czech household

Years	Total component of time-series *rw*: $SS1_{ij} = TS1_{ij} + c1_j \times TS1_{ij} = (1 + c1_j) \times TS1_{ij}$				Total component of time-series *rm*: $SS2_{ij} = TS2_{ij} + c2_j \times TS2_{ij} = (1 + c2_j) \times TS2_{ij}$			
	I Q	II Q	III Q	IV Q	I Q	II Q	III Q	IV Q
1995	0.2229	0.2203	0.2284	0.2298	13 278.7531	14 221.0365	13 374.9400	14 323.6773
1996	0.2215	0.2188	0.2269	0.2283	13 471.1269	14 426.3180	13 567.3138	14 528.9588
1997	0.2200	0.2174	0.2254	0.2267	13 663.5007	14 631.5995	13 759.6876	14 734.2402
1998	0.2185	0.2159	0.2239	0.2252	13 855.8745	14 836.8809	13 952.0614	14 939.5217
1999	0.2171	0.2145	0.2224	0.2237	14 048.2483	15 042.1625	14 144.4352	15 144.8032
2000	0.2156	0.2130	0.2209	0.2222	14 240.6223	15 247.4439	14 336.8090	15 350.0847
2001	0.2142	0.2116	0.2194	0.2206	14 432.9959	15 452.7254	14 529.1828	15 555.3662
2002	0.2126	0.2101	0.2179	0.2192	14 625.3697	15 658.0069	14 721.5566	15 760.6476

Table 8. Time-free residues of real food share (rw) and real incomes (rm) of the average Czech household

Years	Time-free residues (12.1) of rw time-series: $e1_{ij} = rw_{ij} - SS1_{ij}$				Time-free residues (12.2) of rm time-series: $e2_{ij} = rm_{ij} - SS2_{ij}$			
	I Q	II Q	III Q	IV Q	I Q	II Q	III Q	IV Q
1995	9.9228×10^{-4}	7.2104×10^{-3}	-1.3233×10^{-2}	-1.0262×10^{-2}	–796.4131	–1 067.9562	713.4411	652.9827
1996	-5.7965×10^{-5}	-2.5667×10^{-3}	7.7975×10^{-3}	1.8167×10^{-3}	–79.1709	95.8757	309.5164	651.5802
1997	2.1072×10^{-3}	-3.1386×10^{-3}	6.5001×10^{-3}	6.9943×10^{-3}	262.8258	270.9799	298.3686	204.4426
1998	-2.8416×10^{-3}	7.2093×10^{-3}	5.7604×10^{-3}	9.3700×10^{-3}	17.0135	–517.7740	225.3863	331.0062
1999	-4.4818×10^{-3}	-6.8562×10^{-3}	-5.8646×10^{-3}	-1.0533×10^{-3}	–177.4678	–232.4314	461.0644	123.9747
2000	9.3366×10^{-3}	3.3567×10^{-3}	1.8458×10^{-3}	-2.9564×10^{-3}	–1 035.1163	–629.9573	–220.0202	–77.5027
2001	-5.0277×10^{-3}	-1.6605×10^{-3}	-2.4586×10^{-3}	-3.5194×10^{-3}	–154.6386	–319.9464	85.5344	477.2206
2002	-6.8306×10^{-5}	-3.7812×10^{-3}	-3.0168×10^{-4}	-3.8277×10^{-4}	–277.1525	–364.3083	389.4122	404.9942

Table 9. Average Czech household model of real income impacts on the real food shares

Linear model (13): $\varepsilon1_{ij} = \beta \times \varepsilon_{ij} + u_{ij}$		
Values of regression parameter and determination coefficient	$\beta = -4.4138 \times 10^{-6}$	$\rho^2 = 0.1347$
Value of *T*-test and *F*-test	$\lvert T\beta \rvert = 2.1968$	$F(1.31) = 4.8261$
Significance level of *T* and *F*-tests	$\alpha_\beta = 3.5636 \times 10^{-2}$	$\alpha = 3.5636 \times 10^{-2}$

del before its application was statistically tested. The estimated value of the model parameter and the results of the basic statistical verification are contained in Table 9.

From it, it is obvious, that the stationary linear model (13) achieved relatively satisfactory results in the area of statistical verification. Both realised tests (*F*-test of the determination coefficient and *T*-test of model parameter) reached the value of the statistical significance 3.56%. Thus the developed model can be declared as statistically significant. The low level of the attained determination coefficient probably points at the impacts of other demand factors. This finding corresponds to the modern multi-factorial base of demand functions (Koutsoyiannis 1979). Besides the prices and income, the modern microeconomics theory of consumer behaviour mentions lots of other demand factors (credit availability, past level of incomes, past level of own demands and demands of other consumers, consumer's wealth, expectation in the development of prices and income, and government policy).

The application of the developed linear model in the analysed field was based on the evaluation of the regression coefficient:

$$\beta = -4.4138 \times 10^{-6} < 0 \qquad (22)$$

Because the regression parameter β accomplished the condition (15) and *T*-test of the parameter reached the satisfactory level of statistical significance, it is possible to state that food expenditures of the average Czech household are governed by the Engel's Law. Thus the increase in household income brings the decrease in the real share of food expenditures. According to the developed regression model, the income rise by 1 CZK implies the fall of the real food expenditure share by 4.4818×10^{-4}%.

During the research of the Engel's Law in the field of food expenditures of the average Czech household, an interesting fact was discovered at the preliminary decomposition analysis of both time-series. If the periodical components of the time-series analysis were not included into the final analysis, thus the time-free residues being defined only by the formulas (23.1) and (23.2):

$$\varepsilon1_{ij} = rw_{ij} - TS1_{ij} \qquad (23.1)$$

$$\varepsilon2_{ij} = rm_{ij} - TS2_{ij} \qquad (23.2)$$

it would have led consequently to the linear regression model (13) with the positive parameter β:

$$\beta = +7.0833 \times 10^{-7} < 0 \qquad (24)$$

This finding (24) is inconsistent with the general formulation of Engel's Law in the field of the households' food expenditures. It is possible to make an objection to the almost zero value of β. But the model concept of Engel's Law research on the base of residues (23.1) and (23.2) did not reach the acceptable results of basic statistical verification. The value of determination coefficient (r^2) of the other model in form (13) was only 4.5600×10^{-3}. In that case, the significance level a of *F*-test of r^2 achieved the unacceptable value (almost 71%). Similarly, inadmissible results of economical and statistical verification were also reached on the base of the non-linear analysis of the trend function. There were especially examined parabolic, respective cubic trend functions. The achieved facts emphasise the necessity of periodical components for the realised research of the Engel's Law. In a different way, there is a real danger of misrepresenting the results of the realised analysis in the area of the Engel's Law validity.

CONCLUSION

The realised analysis verified the validity of the Engel's Law in the field of food expenditures of the average Czech household. Thus the real shares of food expenditures fell with the rise of real household's incomes. This fact was represented by the negative numeral value of the model parameter β (-4.4138×10^{-6}). According to the estimated value of β, the rise of real income of the average Czech household by 1 CZK implies the fall of the real food expenditure share by 4.4138×10^{-6}%. In addition to the verification of the Engel's Law validity, the research pointed out the importance of the periodical component within the preliminary time-series analysis. The elimination of the time factor without regular periodical oscillation did not provide acceptable results in the examined field of the Engel's Law. In the case of this time-factor elimination, the developed models (linear or non-linear) did not reach the level of statistical significance, either.

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Arrived on 28th August 2003

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