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Original Paper

Demand for food among different income groups of the Slovak population

Ema Lazorčáková, Miroslava Rajčániová*

Slovak University of Agriculture in Nitra, Faculty of Economics and Management, Institute of Economic Policy and Finance, Slovak Republic

ABSTRACT

Slovakia belongs to the countries where households spend a significant part of their income on necessary goods such as food. Inflationary shocks and policy interventions can have significantly different effects on different income groups of the population. Therefore, it is important to understand changes in food demand in different population groups. We employ a linearly approximated almost ideal demand system (AIDS) to estimate a demand system for food commodities in four income quartiles of households. We use the data from the Slovak household budget survey for 2020. The results reveal that if households change their total food expenditures, the most significant changes in food demand are expected in the market for meat. Wealthier households are less sensitive to price changes. In general, demand for food commodities is price inelastic. Regardless of the income quartile of households, the least flexible reaction to a price change is anticipated for bread and cereals. Demand elasticities help to foresee impacts of policies supporting consumption of households.

KEYWORDS: demand for food, Almost Ideal Demand System, consumer expenditures

JEL CLASSIFICATION: D12, D31, Q11

INTRODUCTION

Food demand research is crucial to understand how households allocate their incomes to commodities essential for their lives. In Slovakia, as in many other Central European countries, a significant part of household income is devoted to food. In the last two decades, food expenditures built on average up to 19-25% of total disposable per capita income and 22-26% of total consumer's expenditures (data from SO SR). The phenomenon of food spending is particularly pronounced in households with lower per capita income, where a larger share of income is directed towards essential consumption.

* Corresponding author: Miroslava Rajčániová, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 94976 Nitra, Slovakia, e-mail: miroslava.rajcaniova@uniag.sk

In recent years, Slovakia has experienced various economic shifts, including inflationary pressures and policy interventions (e.g. European Green Deal and Farm to Fork Strategy) that have impacted food prices. These economic changes can lead to varying effects on different income groups of households, amplifying the importance of studying demand elasticities. Knowing the response of consumers to changes in food prices allows policymakers to better predict and mitigate the impacts of economic shocks. By analyzing the demand elasticities for food, this paper aims to shed light on the sensitivity of Slovak households to price changes and assess the implications for welfare and policy. Such an understanding is pivotal for formulating targeted economic policies that protect vulnerable groups and promote equitable growth. This analysis is grounded on the broader context of economic literature, reflecting both regional and global studies of food consumption patterns. In this paper we employ the Linear Approximate Almost Ideal Demand System (LA-AIDS) model that offers high flexibility and simple application to data on household expenditures. The methodology is widely used in the most recent literature: e.g. Shibia et al. (2017) used LA-AIDS to examine a household demand system for meat products in Kenya; Anindita et al. (2022) found LA-AIDS to be the most suitable demand system to analyze the demand for carbohydrate sources of food in Central Java; da Silva Pinto et al. (2022) opted for the model in their study of demand for Indonesian cloves; Siddique et al. (2020) estimated the demand elasticity of rice in Bangladesh using an LA-AIDS, or Khan et al. (2019) used this demand system to analyze the elasticity of non-carbonated drinks in Pakistan.

MATERIAL AND METHODS

To estimate the Slovak households' demand for food we employ the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980). The AIDS model builds on the neoclassical theory of consumer behaviour, it allows to estimate a system of demand functions for all commodities in the consumption basket and derives the demand functions as expenditure share equations. A complication of the AIDS model is that it uses a price index that leads to non-linear demand functions. Therefore, several modified versions of the model have been proposed to simplify empirical estimation of its parameters. Deaton and Muellbauer (1980) suggested a linear approximation of the demand system (LA-AIDS) by substituting the non-linear price index for a linear Stone price index. Hence, the demand equations are:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln \frac{TE}{SI} \qquad \text{with } \ln SI = \sum_{i=1}^{n} w_i \ln P_i \tag{1}$$

where w_i – share of expenditures for i-th commodity in total expenditures, P_i – price of i-th commodity, TE – total expenditures for the consumption basket, SI – Stone price index (to avoid a simultaneity problem – having the variable w_i on both sides of the demand equations – we used average values of w_i to calculate the Stone price index), α_i, β_i, γ_{ij} – parameters of the model (estimated by iterative SUR – seemingly unrelated regression).

The system of demand equations in the LA-AIDS model has to fulfill theoretical properties that are reflected in restrictions placed on its parameters: a) adding up: $\sum_{i=1}^{n}\alpha_i = 1$, $\sum_{i=1}^{n}\gamma_{ij} = 0$, $\sum_{i=1}^{n}\beta_i = 0$, b) homogeneity: $\sum_{j=1}^{n}\gamma_{ij} = 0$, c) symmetry: $\gamma_{ij} = \gamma_{ji}$.

Price and expenditure elasticities quantifying the reaction of consumer demand to changes in demand determinants can be obtained as (see Green and Alston, 1990; Green and Alston, 1991; Buse, 1994):

- Uncompensated (Marshallian) price elasticities of demand e_{ij}:

$$e_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i}\frac{w_j + \sum_{k=1}^{n}\gamma_{kj}\ln P_k}{1 + \sum_{k=1}^{n}\beta_k \ln P_k} \qquad \text{with } \delta_{ij} = 1 \text{ if } i = j \text{ and } \delta_{ij} = 0 \text{ if } i \neq j \tag{2}$$

- Expenditure elasticity of demand e_i:

$$e_i = 1 + \frac{\beta_i}{w_i} \tag{3}$$

For the purpose of this study, we assume that consumers apply multi-stage budgeting in their decision making process (weak separability of the utility function). This is, they first allocate total expenditures between food and non-food consumption (first stage) and then they divide the group's expenditure among commodities within that group (second stage). We focus only on the second stage of budgeting representing demand for food. Using the LA-AIDS model we build a system of LA-AIDS demand equations with food expenditures and 11 food commodities entering the system (Figure 1).

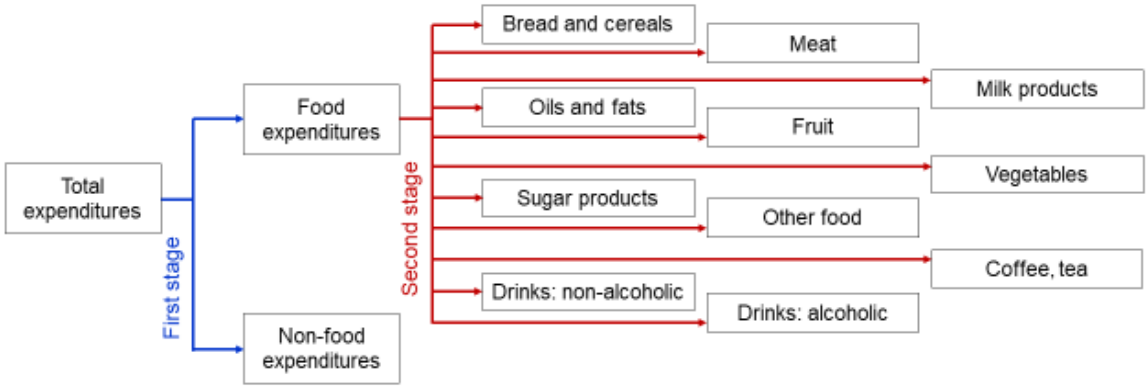

Figure 1 Breakdown of total consumer expenditures
Source: own elaboration

Data

The study uses data from the Slovak household budget survey from 2020. The dataset provides information on consumption expenditures for 302 types of goods and services, on other expenditures, and on quantities consumed of 71 types of food for 4633 households. We adjusted the dataset in the following way: 1) food items (including beverages) were

aggregated into 11 food categories (for expenditures and for quantities): bread and cereals, meat, milk products, oils and fats, fruit, vegetables, sugar products, other food, coffee and tea, non-alcoholic drinks, alcoholic drinks, 2) households reporting zero consumption or zero expenditures (or both) in any of the 11 food categories were excluded from the sample what retained 2486 households in the dataset, 3) shares of the 11 food categories in total food expenditures of households were calculated ($w_i = TE_i / TE$), and price of each of the 11 food categories was calculated ($P_i = TE_i / Q_i$), 4) households were divided into four income quartiles according to their total gross per capita expenditures (assuming that total gross expenditures equal total income).

RESULTS AND DISCUSSION

Food expenditures are an integral part of households' budgets. In Slovakia, total food expenditures reached on average 1385 EUR per person in 2020. The most important food commodities in the consumption basket of Slovak households are meat, bread and cereals, and milk products, that are together responsible for 50% of total food expenditures (individually for 24%, 14% and 12%, respectively). The three commodities are the core of the human diet and provide basic nutrients. Other valuable sources of nutrients are fruit and vegetables, which build up 8% and 9%, respectively, of food expenditures. The remaining third of food expenditures is spent for oil and fats, sugar products, miscellaneous food products and beverages (Figure 2).

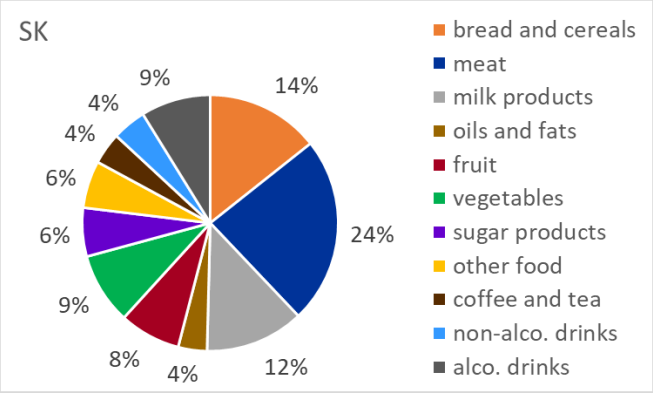

Figure 2 Share of food commodities in total food expenditures
Source: HBS, own elaboration

The percentage structure of food expenditures is similar across different income groups of households. However, when looking at absolute values of food expenditures and food consumption, significant differences can be revealed. Wealthiest households in the fourth income quartile report approximately two-times higher values of per capita food expenditures and quantities consumed than households from the first income quartile (Table 1). For some commodities the multiple of expenditures is much higher than the multiple of consumption, indicating that households from the fourth income quartile pay a higher price for food they buy.

Expenditures, consumption	bread, cereals	meat	milk products	oils, fats	fruit	vege-tables	sugar products	other food	coffee, tea	non-alco.	alco. drinks
Quartile 1 [expenditures in EUR/cap.; consumption in kg/cap. or l/cap.]											

Expenditures	140.1	220.4	113.2	35.3	59.1	76.0	52.0	55.9	34.1	39.0	64.2
Consumption	61.3	49.2	57.3	12.2	38.8	57.8	15.5	20.8	2.8	88.5	29.5
Quartile 4 [expenditures in EUR/cap.; consumption in kg/cap. or l/cap.]											
Expenditures	260.7	429.4	237.3	65.9	163.3	173.6	119.5	112.4	80.9	81.1	198.1
Consumption	91.0	86.2	99.4	19.3	90.7	112.7	22.8	36.9	5.3	160.7	71.3
Quartile 4 / Quartile 1 [index]											
Expenditures	1.9	1.9	2.1	1.9	2.8	2.3	2.3	2.0	2.4	2.1	3.1
Consumption	1.5	1.8	1.7	1.6	2.3	1.9	1.5	1.8	1.9	1.8	2.4

Table 1 Food expenditures and food consumption – selected quartiles of households
Source: HBS, own elaboration

Consumers from the four income quartiles of households are expected to react differently to changes in food markets. Their behavior can be characterized by means of demand elasticities. For Slovak households, we have calculated the demand elasticities using the parameters estimated with the LA-AIDS model[1]. In the next sections, we will first assess the expenditure elasticity of demand for food products, then the own-price elasticity and lastly the cross-price elasticity.

The sensitivity of demand for food to changes in total food expenditures is given by expenditure elasticities of demand (Table 2). The lowest expenditure elasticity is evidenced for milk products and the fourth income quartile of households – if food expenditures increase by 1%, quantity demanded of milk products by these consumers increases by 0.817% (ceteris paribus). The highest expenditure elasticity is documented for oils and fats and the second quartile of households (1.179). Expenditure elasticity decreases with increasing income quartile for milk products, for the other commodities the pattern is mixed. In general, bread and cereals, milk products and non-alcoholic drinks are necessities for consumers. On the other hand, meat is a luxury. The classification of all other food commodities depends on the income quartile of households; expenditure elasticities oscillate around one meaning that for Slovak consumers those food commodities are a superior good at the border between necessities and luxuries.

Elasticity	Bread, cereals	Meat	Milk prod.	Oils, fats	Fruit	Vege-tables	Sugar prod.	Other food	Coffee, tea	Non-alco.	Alco drinks
Expenditure elasticity of demand: e_i											
Quartile 1	0.858	1.132	0.866	0.988	0.998	1.104	0.955	0.938	1.042	0.957	1.092
Quartile 2	0.920	1.169	0.840	1.179	1.029	1.029	0.867	1.006	0.924	0.840	0.960
Quartile 3	0.871	1.164	0.823	1.071	0.991	0.947	1.001	0.972	0.972	0.873	1.178
Quartile 4	0.938	1.167	0.817	1.045	1.043	1.000	0.981	0.925	0.948	0.822	1.052
Price elasticities of demand: e_{ii}											
Quartile 1	-0.548	-0.949	-0.997	-0.817	-0.867	-0.820	-0.879	-0.653	-0.927	-1.065	-0.669
Quartile 2	-0.602	-0.904	-0.975	-0.794	-0.844	-0.753	-0.850	-0.756	-0.912	-0.988	-0.784
Quartile 3	-0.551	-0.908	-0.919	-0.777	-0.736	-0.781	-0.787	-0.569	-0.900	-1.053	-0.699
Quartile 4	-0.491	-0.830	-0.852	-0.731	-0.698	-0.743	-0.802	-0.576	-0.965	-0.986	-0.711

Table 2 Expenditure and own-price elasticity of food demand by income quartile of households
Source: HBS, own calculation

The demand for all 11 food commodities included in the demand system is found price inelastic (Table 2). This holds across all income quartiles of households, the only exception is

[1] Because of space limitations, parameter estimates for demand equations in the LA-AIDS model are not reported, they are available from the authors.

demand for non-alcoholic beverages (mineral water, fruit and vegetable juices, carbonated drinks, etc.) of consumers from the first and the third income quartile with own price elasticity slightly below -1. Within each income group of households, the least price elastic demand is for bread and cereals, followed by demand for alcoholic drinks (first and third quartile), for fruit (fourth quartile) or for vegetables (second quartile). The most price elastic demand is for non-alcoholic drinks, although still price inelastic for the second and the fourth quartile of households. In general, demand for the 11 food commodities is less elastic for households with higher incomes than for households with lower incomes. The biggest variability in (own) price elasticity of demand is for fruit (the group of other food products not evaluated). If the price of fruit increases by 1%, consumers from the first income quartile of households decrease their consumption by 0.817%, while consumers from the fourth income quartile by 0.698% (ceteris paribus). Inelastic demand for food commodities indicates that if price of a commodity increases, expenditures for the particular commodity will also increase.

Cross-price elasticities signal the reactions of demand for one commodity to the change in price of another commodity. As there are 110 mutual interactions for each income quartile of households in our demand system, we will just showcase cross-price elasticities of demand for fruit and for vegetables (Table 3), as an example of healthy food consumption. Positive cross price elasticities reveal that fruit and vegetables are mutual substitutes for consumers[2]. Fruit is considered a substitute to oils and fats and to sugar products. On the other hand, fruit is considered a complement to bread and cereals and to meat. The relationship between fruit and milk products / other food / drinks depends on the income quartile of households. Vegetables are a complement to bread and cereals, to meat and to alcoholic drinks. No clear substitutionary relationship of vegetables to other food commodities was revealed. Depending on the income quartile of households, the relationship between vegetables and milk products / oils and fats / sugar products / other food / coffee and tea / non-alcoholic drinks varies.

Elasticity	Bread, cereals	Meat	Milk prod.	Oils, fats	Fruit	Vege-tables	Sugar prod.	Other food	Coffee, tea	Non-alco.	Alco drinks
Demand for fruit: e_{ij}											
Quartile 1	-0.055	-0.050	-0.062	0.045	-0.867	0.047	0.010	-0.068	0.016	0.016	-0.030
Quartile 2	-0.113	-0.057	-0.117	0.009	-0.844	0.032	0.036	0.011	0.013	-0.022	0.024
Quartile 3	-0.061	-0.092	-0.079	0.035	-0.736	-0.002	0.046	-0.067	0.029	-0.023	-0.044
Quartile 4	-0.092	-0.128	0.010	0.010	-0.698	0.027	0.007	-0.031	-0.046	-0.029	-0.072
Demand for vegetables: e_{ij}											
Quartile 1	-0.103	-0.139	0.013	-0.031	0.031	-0.820	0.012	0.000	0.017	-0.012	-0.068
Quartile 2	-0.047	-0.118	-0.015	0.000	0.025	-0.753	-0.018	-0.008	-0.020	-0.019	-0.056
Quartile 3	-0.052	-0.126	0.028	-0.006	0.001	-0.781	-0.002	0.024	-0.001	0.008	-0.040
Quartile 4	-0.091	-0.057	0.029	0.008	0.027	-0.743	-0.051	-0.030	-0.026	-0.016	-0.051

Table 3 Cross-price elasticities of demand for fruit and vegetables by income quartile of households

Source: HBS, own calculation

Knowing the demand elasticities of food commodities is important for economic as well as for public health policies. Slovak households do not consume sufficient amounts of fruit and

[2] Although the cross price elasticity of demand for fruit with respect to the price of vegetables is negative for the third income quartile of households, when transforming the elasticity into compensated /Hicksian/ price elasticity, a positive value indicates that fruit is a substitute to vegetables also for the third income quartile of households.

vegetables (Matošková et al., 2021). This is especially the case of low-income households in the first income quartile. Economic policies can support their consumption in two main ways. The first one are price-oriented policies as for example tax reductions or subsidies. The second one are income-oriented policies resulting in higher spending for food including fruit and vegetables. If the policies had the goal to increase per capita fruit consumption in low-income households by 10%, the calculated elasticities can be helpful in comparing the costs of either approach. Price-oriented policies must reduce the price of fruit by 11.53%. The government would need 7.94 EUR to support the consumption of a representative consumer from the first income quartile of households. Income-oriented policies must increase disposable resources for food spending by 10.02%. The government would need 89.10 EUR to support food expenditures of a representative consumer from the first income quartile of households. However, any change of prices or food expenditures has an impact on other markets, too. For example, while a decrease in the price of fruit decreases the quantity of vegetables consumed, an increase in food expenditure increases the consumption of vegetables. Demand systems, like the LA-AIDS model used in this study, enable to estimate a system of demand equations and a set of demand elasticities that interconnect relevant markets.

CONCLUSIONS

The structure of food expenditures is similar across different income groups in Slovakia, but significant differences appear when examining absolute values. Wealthiest households (fourth income quartile) consume and spend nearly twice as much on food per capita as those in the first income quartile. These differences reveal that households in different income quartiles react differently to changes in food markets. We have further analyzed this issue using the LA-AIDS model. Our results show that higher income groups typically exhibit less elastic demand compared to lower income groups. Bread and cereals, milk products, and non-alcoholic drinks are necessities, whereas meat is considered a luxury. Understanding these demand elasticities is crucial for informing public policies, particularly those aimed at supporting low-income households. However, it must be noted that many parameters in our model are not significant, and the results should be taken with a grain of salt. For further research we recommend estimating more possible demand systems and incorporating other demographic variables.

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