ESTIMATION OF PRICE AND INCOME ELASTICITY OF DEMAND FOR MILK IN SLOVAKIA

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Abstract: *Despite the fact that situation has changed significantly in recent years and the share of milk production in the total agriculture production tends to decline, milk still represents a significant part of the food products in Slovak households. The study presents the important data on dairy sector balances, focuses on prices and income elasticity. Using dataset from the Household Budget Survey of Slovakia, we estimated the price elasticity of demand for skimmed and whole milk. Due to the nature of data, we used the Cragg's double hurdle model for estimation, in the time period from 2006 to 2012. The results show that the demand for whole milk is elastic (1.42) and for skimmed milk is inelastic (0.53). The rise in prices of whole milk causes an increase in the consumption of skimmed milk by 0.30% and higher prices of skimmed milk leads to increasing of demand for whole milk by 0.37%, therefore they are substitutes. The influence of other dairy products such as a dried milk, yoghurt, cheese is mainly either insignificant (whole milk) or very low (skimmed milk). The income factor positively influences the consumption of milk and leads to a small increase in the consumption of skimmed milk what suggest that both type of milk are normal goods.*

Keywords: *demand for milk, price elasticity, income elasticity, double-hurdle model*

1. INTRODUCTION

Milk belongs to the staple food products and it is also a crucial commodity among the European Union states. It is produced in every single EU country and generally, the dairy sector contributes to 12.2% of the total agricultural output, right after vegetables and horticultural plants (13.2%). In Slovakia, the milk production represents just about 13.5% of total agriculture production (Eurostat, 2017). Despite the fact that this percentage share has been declining over the past years, dairy production has a significant position in the economy. The other words, it has an impact on the welfare of the economy as a whole and it affects both ends of the food supply chain, i.e. producers and consumers (households). The effect on consumers also depends on price volatility and the extent to which retail prices react to producer prices (Gilbert and Morgan, 2010). Garcia-German (2014) states that higher volatility in retail prices has a greater influence on the consumers who spend a larger scale of their income on food.

The agriculture economists have started to focus their attention on the analysis of the pricing market structure and consumption of households. Many recent studies also have concentrated on marketing activities influencing the demand for dairy products and paid attention to factors affecting demand and market prices. Socio-demographic effects, such as the age and gender of the consumers, household size, the composition of household members, level of monthly

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income, health problems effect, urbanization, ethnicity, the region of residence, seasonality etc. (Heien and Wessells 1988; Gould, 1996; Hatirli, et. al., 2004; Goktolga et. Al. 2006; De Alwis, et.al., 2011; Denver and Jensen, 2014) have been identified as household characteristics representing the important role in consumption and in the purchasing behavior. Dong et. al. (2004) examined fluid milk purchasing behavior with panel data from New York households, using a Double-hurdle model. From the empirical testing was found that the prices are inelastic and generic dairy advertising increases the probability of market participation and simultaneously purchase quantity and incidence. Davis et. al. (2009) examined demand elasticity for fluid milk products in the United States, using a censored translog demand system and the results showed that price and income are the main determinants of the demand for dairy products. Alviola and Capps (2010) used the probit model to find out the impact of the selected demographic variables connected with the purchase of organic fluid milk. They ascertained that factors like earnings and education have a significant position in the household choice of purchasing organic milk. Tiryaki and Akbay (2009) used the multinomial logit procedure to study selected socioeconomic and demographic aspects of consumers that determine households' fluid milk consumption. The results concluded that as the earnings grow then household tends more to consume processed milk rather than buying unprocessed milk. The effect of income was found as the highest on the probability of consuming processed milk. Bai et al. (2008) adopted a Tobit model to estimate the influences of socio-demographic characteristics of urban consumers on their fluid milk consumption in Qingdao in China. The major results showed that fluid milk consumption in urban Qingdao is much higher compared to China's national level and also income has the positive influence on milk consumption.

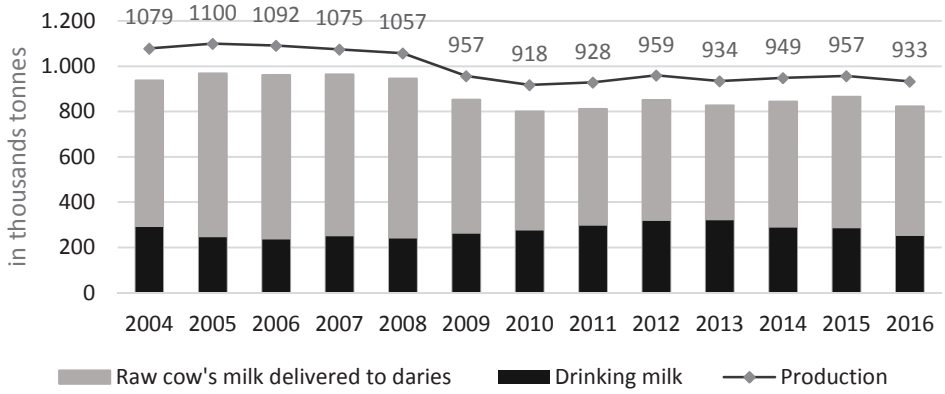
The objective of the paper is to estimate price elasticity of demand for skimmed and whole milk in Slovakia. Using the household dataset from the Household Budget Survey, we focus on the time period of 2006-2012. The paper is organized in the following parts - the next section describes the Slovak dairy sector, its current changes in the market structure, productivity, consumption and trade in Slovakia. The second part provides a description of the theoretical model used to test the elasticity of demand, and summaries the data and variables used in the econometric analyses. In the third part, the estimations of tests are presented and the final part summarizes the results and conclusions.

1.1. MARKET STRUCTURE OF DAIRY SECTOR IN SLOVAKIA

Slovak agriculture has differed strongly from the other European Union countries, largely within its farm structure (Swinnen, at al., 2006). Dairy sector has undergone rapid structural changes in the past decade and the number of farms plummeted by more than 35%, mainly due to the low purchase prices. It was one the reasons of the milk crisis in 2008-2009, 2012, and in 2015-16. Just during the last 3 years, the number has dropped from 483 registered dairy farms in 2015 to only 424 in the September 2018 (12% reduction).

In 2016, milk production of Slovakia reached 933.3 million kg which represents a decrease by 2.5% over the previous year and 163 million tones of cow's milk was produced within the EU. Compared to these countries, Slovakia is just a small dairy producer and the production accounted for just 0.5% share of EU milk deliveries. The majority of Slovak milk is produced on the farms. They are run as cooperatives or private enterprises (limited company or trading companies) and most of the milk is used for processing by buyers. During the observed period, delivery on production was on average about 89% (see Figure 1). Forty dairy companies and organizations operated with direct milk collection from the agricultural holdings and just 10 of them operated with own-milk processing.

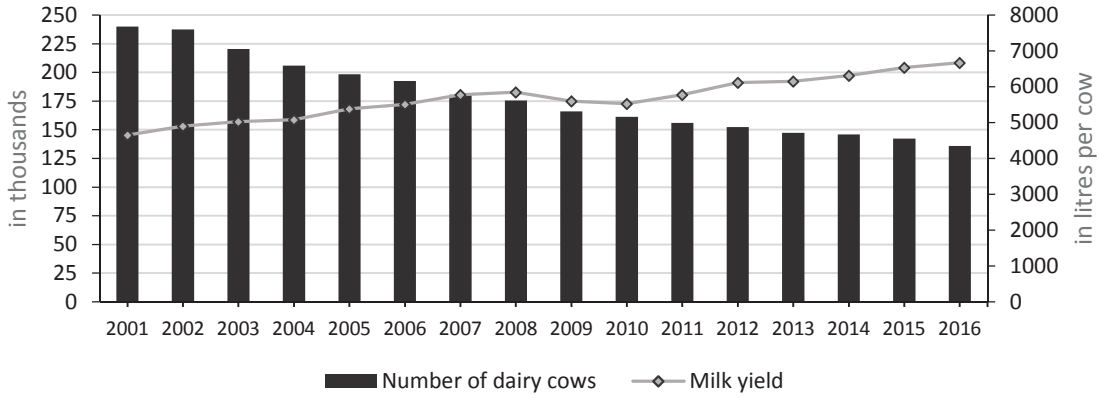
Figure 1 Cow's milk production, milk deliveries, drinking milk



Source: Eurostat

In 2016, 822.7 thousand tones of the cow's raw milk available in the dairy sector was processed into a lot of fresh and manufactured products. 30.5% of processed milk was used as drinking milk including raw milk, whole milk, semi-skimmed and skimmed milk without any additives and relates only to milk directly intended for consumption. The rest of the milk was used for the proceeding of other dairy products (Eurostat, 2018).

Figure 2 Number of dairy cows (left axis), milk yield (right axis)



Source: Research Institute of Agriculture and Food Economics

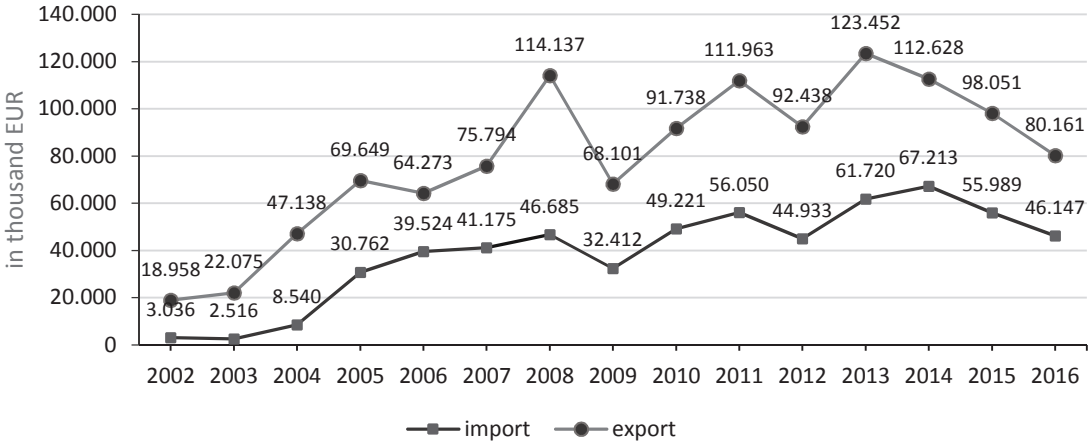
Figure 2 shows the number of dairy cows and milk yields between the years 2001-2016. Since 2006, the average number of dairy cows in the farms decreased by almost 42% (from 192.5 thousand to 135.9 thousand) and compared to 2001, by more than three-quarters. Unlike the sharp decrease in dairy cows, average milk yields rose by 21% since 2006 and compared to the year 2001, by 43.3%.

A lot of consumers have been changing their purchasing habits in accordance with the nascent 'healthy trends'. This is also one of the factors affecting milk consumption. According to the dairy report of Euromonitor (2017), the main consequences of these trends are increased shares of product innovations based for instance on full-fat fresh milk and other milk alternatives such as soy drinks, goat milk, lactose-free drinking milk products or organic brands. In 2016 the annual consumption of cow's milk amounted to 173.6 kg per capita and compared to 2006 it

increased by 15.5%. However, this amount still represents just nearly 80% of the recommended level (220 kg per year).

In 2017, Slovak export of milk and milk products accounted for just 0.7% of EU dairy export. The increase in exports and imports would stem from the entry of Slovakia into EU in 2004. Since then a substantially larger part of the raw milk and milk products has been bought directly by foreign companies. Dairy products, converted into milk equivalent, were exported abroad as a share 63.5% (the year 2017) and 58.1% (the year 2016) from the milk deliveries.

Figure 3 Foreign trade of milk



Source: Research Institute of Agriculture and Food Economics

In 2007, the export sales grew rapidly and reached more than 114 million EUR. In 2016, Slovakia exported milk and milk products amounting to 80.1 million EUR (Figure 3). Bulk and packed milk represented 187 thousand tones and 99% of this amount went to the other European Union countries (intra-trade). The main business partners for export of bulk milk were Germany and Italy, for packed milk Hungary and for other dairy products the Czech Republic (cheese, whey, cream) or Spain (yoghurt and buttermilk). In the same year, milk products were imported to Slovakia amounting to 46 million EUR, which constituted 234.3 thousand tones of dairy products. The main importers were the Czech Republic (packed and bulk milk, cream, yoghurt, buttermilk), Poland (cheese), Romania (whey) and Germany (butter, skimmed milk powder).

2. DATA AND METHODOLOGY

The aim of this paper is to estimate price elasticity of demand for skimmed and whole milk in Slovakia. We used data from the Household Budget Survey of Slovakia for period 2006 - 2012 and due to the nature of the dataset, the Cragg´s double hurdle model was applied to measure the elasticity.

The month consumption of whole/skimmed milk per household was used as the main dependent variable entering the model. To estimate the price elasticity was essential to determine prices of these products because the dataset did not contain this information. By following Sousa (2014), the prices were derived from expenditures and quantities of consumed milk and simultaneously showed differences of each household. For households with zero consumption, we calculated the average prices of 8 regions by years and quarters, and missing prices were substituted with new estimated prices which were also used as the main explanatory variables.

Besides the whole and skimmed milk prices, the prices of dried milk, yoghurt, cheese, and other dairy products were also included in the model.

Models contained variables representing household characteristics or time trend. Selection of variables was based on studies focus on the demand for dairy products, e. g. Heien and Wessells (1988); Dong et al. (2007); Bouamra-Mechemache, et al. (2008). Table 1 shows the list of all variables used in the model.

Table 1: Variables entering models

Dependent variables (Y_j)	***Definiton***
ln_c_milk_whole	log monthly consumption per household (l)
ln_c_milk_skim	log monthly consumption per household (l)
Instruments (Z_j)	***Definiton***
ln_income	log monthly income per household (EUR)
d_whole	dummy variable for consumption of whole milk, 1 – positive amount of consumption, otherwise 0
d_skim	dummy variable for consumption of skim milk, 1 – positive amount of consumption, otherwise 0
Explanatory variables (X_j)	***Definiton***
ln_p_milk_whole	log price of whole milk per l
ln_p_milk_skim	log price of skim milk per l
ln_p_milk_dried	log price of dry milk per l
ln_p_yogurt	log price of yogurt per 100 g
ln_p_cheese	log price of cheese per 100 g
ln_p_other_dairy	log price of other dairy products 100 per g
ln_p_coffee	log price of coffee per 100 g
ln_p_tea	log price of tea per 100 g
ln_p_cocoa	log price of coca per 100 g
ln_income	log monthly income per household
age_hh	age of head of household
male_hh	dummy variable, gender of head of household, 1 – man, 0 – woman
employed_hh	dummy variable for work status of head of household, 1 – employed, 0 – unemployed or economically inactive person
n_members	number of members of household
sp_household	dummy variable, 1 – single person household, otherwise 0
n_retirees	number of retirees in household
n_teenegers	number of teenagers in household (age 13 – 18)
n_children	number of children in household (age < 12)
region	dummy variables for 8 regions of Slovakia
year	time trend for period 2006 - 2012

Source: HBS, own processing

The problem of the censoring shows particularly in the studies using microeconomic data. The database used in this study contains a significant number of households with zero expenditure on milk. It might be caused by several reasons: the period of research is short; households never buy milk or households never buy milk at the given prices or income.

Estimation of demand by OLS at these circumstances would lead to biased and inconsistent results (Amemiya, 1984). Studies analyzing the demand for food, e.g. Gao et al. (1995), Burton et al. (1996), Yen and Jones (1997), Sharpe et al. (2001), Newman et al. (2003), Mabiso et al. (2005), Mutlu and Gracia (2006), Zhang et al. (2008), Wan and Hu (2012) Eakins, 2016 or Cupak et al. (2016), often use the Cragg´s double hurdle model (Cragg, 1971).

The double-hurdle model is appropriate to use if consumers make decisions in two steps – hurdles: *participation* and *consumption* decision. The first hurdle is estimated by Probit model and the second one with a truncated Tobit model. *The participation* step is described by equations

$$d_j^* = z_j\gamma_j + u_j \qquad u_j \sim N(0,1) \tag{1}$$

$$d_j = \begin{cases} 1 \; if \; d_j^* > 0 \\ 0 \; if \; d_j^* \leq 0 \end{cases} \tag{2}$$

where d_j^*represents unobserved latent variable and $d_j$is observed binary variable. The second step – how much household consume is described by equations

$$y_j^* = x_j\beta + v_j \qquad v_j \sim N(0,\sigma^2) \tag{3}$$

$$y_j = \begin{cases} y_j^* \; if \; d_j = 1 \; and \; y_j^* > 0 \\ 0 \; else \end{cases} \tag{2}$$

where y_j^* is unobserved latent variable and $y_j$is actual expenditure on milk which is equal to y_j^* only in the case that this latent variable takes positive values and participation step is equal to 1. Explanatory variables that determine participation and expenditure hurdles are label as z_j andx_j. Estimation of coefficients is made by maximum likelihood function.

The means and standard deviations of regression variables for the full sample, for households with positive consumption of whole milk, and for households with positive skimmed milk consumption are presented in Table 2. Average Slovak household has 2.82 members from which 0.34 consists of retirees, 0.21 teenagers (13 - 18 years old) and 0.35 children younger than 13 years.
Average monthly income is 1 098 EUR for the full sample, for households consuming skimmed milk it is by 5 EUR more and for households consuming whole milk by almost 100 EUR more. Average consumption is 1.61 liters of whole milk with an average price of 0.70 EUR per liter and 11.92 liters of skimmed milk with an average price of 0.58 EUR per liter. Households with positive consumption of whole milk usually consume 9.69 liters of whole milk per month and 7.07 liters of skimmed milk. On the other hand, households with positive consumption of skimmed milk consume 13.26 liters per month of this kind of milk and 3.92 liters of whole milk. Average prices of other dairy products like yoghurt, cheese, and prices of tea, coffee, and cocoa are also displayed in Table 2.

Table 2: Summary statistics

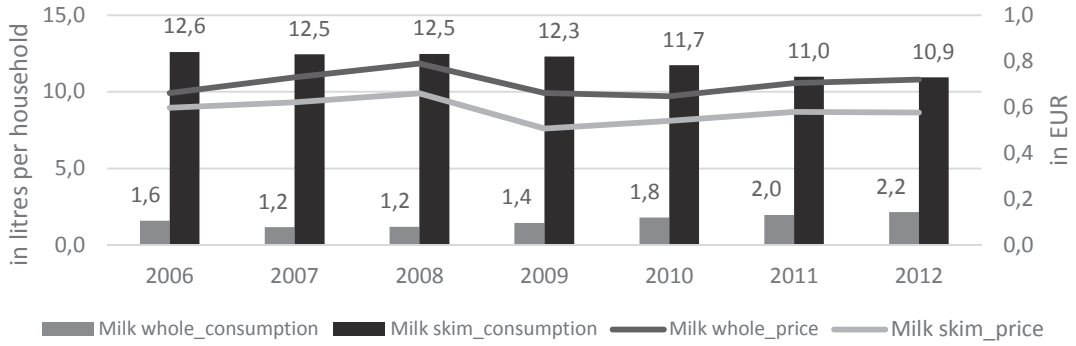
Variable	*Full sample*		*Sample with positive whole milk consumption*		*Sample with positive skim milk consumption*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
c_milk_whole	1.61	5.62	9.69	10.54	0.90	3.92
c_milk_skim	11.92	11.93	7.04	9.33	13.26	10.78
income	1098	743	1192	719	1103	744
p_milk_whole	0.70	0.11	0.70	0.19	0.70	0.10
p_milk_skim	0.58	0.10	0.58	0.10	0.58	0.10
p_milk_dried	0.70	0.21	0.72	0.24	0.70	0.21
p_yogurt	0.26	1.45	0.26	0.07	0.26	1.53
p_cheese	0.57	0.12	0.58	0.12	0.57	0.12
p_other_dairy	0.26	1.39	0.25	0.10	0.25	1.46
p_coffee	1.49	9.27	1.47	0.94	1.49	9.77
p_tea	0.56	1.02	0.60	1.09	0.57	1.03
p_cocoa	0.61	0.15	0.62	0.16	0.60	0.15
age_hh	51.8	14.61	51.2	14.57	51.81	14.50
male_hh	0.68	0.47	0.72	0.45	0.68	0.47
employed_hh	0.64	0.48	0.67	0.47	0.65	0.48
n_members	2.82	1.43	3.02	1.45	2.86	1.42
sp_household	0.22	0.41	0.16	0.37	0.20	0.40
n_retirees	0.34	0.61	0.35	0.63	0.34	0.61
n_teenegers	0.21	0.51	0.22	0.53	0.22	0.51
n_children	0.35	0.69	0.42	0.74	0.35	0.69

Source: HBS, authors´ calculations

3. RESULTS

From 2006, consumption of skimmed milk had a declining trend (Figure 4). In 2006, the average consumption of skimmed milk per household constituted 12.6 liters and six years later it decreased by almost 2 liters. However, consumption of whole milk increased during the observed period by 37.6% and from 2007 had the stable rising trend. Consumer prices of both kinds of milk show a similar volatile pattern. After the reaching maximum in 2008, prices declined sharply and from 2009 increased gradually till 2012.

Figure 4: Price and consumption of whole and skim milk



Source: HBS, author's calculations

Table 3 represents the estimated double-hurdle model for whole and skimmed milk. Whole milk is own price elastic, 1 % increase in the price causes 1.4 % decrease in consumption, in comparison with skimmed milk (0.5 % decrease in consumption caused by 1 % increase in price) that is price inelastic. The cross-price elasticity indicates that whole and skimmed milk are substitutes. An increase in whole milk prices causes an increase in the consumption of skimmed milk by 0.30 % and in the case of the rising price of skimmed milk it is by 0.37 %. Influence of prices of dried milk, yogurt, cheese, and other dairy products is mainly either insignificant (whole milk) or very low (skimmed milk). The same applies to the prices of coffee, tea or cocoa.

The coefficient of income elasticity is significant for skimmed milk but not significant for whole milk. Its value 0.12 indicates that it is a normal good, therefore an increase of income leads to a very small increase in the consumption of skimmed milk. With the rising number of household members obviously rises consumption of milk. The grow of consumption is caused mainly by children, teenagers, and retirees.

Table 3: Estimation of DH model for whole and skim milk

Variable	***Milk whole***		***Milk skim***	
	Coef.	***Std. Err.***	***Coef.***	***Std. Err.***
ln_p_milk_skim	.3674***	.0965	-.5257***	.0291
ln_p_milk_whole	-1.415***	.0696	.3032***	.0376
ln_p_milk_dried	.0181	.0471	-.0496***	.0165
ln_p_yogurt	.1514**	.0704	.0588**	.0230
ln_p_cheese	.0210	.0736	-.0863***	.0239
ln_p_other_dairy	.0396	.0394	-.0181	.0133
ln_p_coffee	.0352	.0299	.0446***	.0096
ln_p_tea	-.0156	.0168	-.0207***	.0055
ln_p_cocoa	-.0026	.0654	-.1164***	.0225
ln_income	.0247	.0374	.1230***	.0123
age_hh	.0049***	.0016	.0036***	.0005
male_hh	.0703*	.0369	.0106	.0114
employed_hh	.0805*	.0447	-.0668***	.0145
n_members	.1191***	.0184	.1627***	.0063
sp_household	-.1247**	.0587	-.2049***	.0171
n_retirees	.0751**	.0297	.0299***	.0100
n_teenegers	.0047	.0315	.0422***	.0107
n_children	.1127***	.0263	.1111***	.0091
TT	.0419	.0682	.1456***	.0192
TN	.1518**	.0567	.0786***	.0187
NR	.0399	.0626	.1082***	.0187
ZA	.1003*	.0553	.0183	.0189
BB	.0560	.0612	.0627***	.0199
PO	.1935***	.0629	.0797***	.0202
KE	.0596	.0619	-.0274	.0190
year	-.0267***	.0085	-.0278***	.0027
_cons	54.60	17.19	56.39***	5.588
selection_ll				
ln_income	.2404***	.0170	.2065***	.0173
d_skim	-1.381***	.0272	-	-

d_whole	-	-	-1.196***	.0234
_cons	-1.539***	.1177	.0699	.1169

Source: HBS, author's calculations

*,**,*** denote significance at the 10%, 5% and 1% significance levels

The latest part of Table 3 contains the effect of income and dummy variables for skimmed and whole milk. All parameters are statistically highly significant. Income positively influences the decision to consume milk and dummy variable d_skim in the model for whole milk has negative value, which means the consumption of skimmed milk by the household has a negative effect on the decision to consume whole milk and vice versa.

CONCLUSION

The study employed the econometric techniques to analyze the price and income elasticity for whole and skimmed milk in Slovakia. The Household Budget Survey data were used in order to build the Cragg's double hurdle model for the time period from 2006 to 2012. To estimate the price elasticity, prices were derived from expenditures and quantities of consumed milk per household. The empirical results show that households are more likely to buy skimmed milk. Demand for skimmed milk was shown as inelastic and for whole milk as elastic. Findings also implied that the observed dairy products are substitutes because an increase of whole milk prices leads to the increase in the consumption of skimmed milk and vice versa. The number of household members, mainly children, teenagers and retirees, affects the consumption of milk and the income is considered as another factor that positively influences the amount of consumed milk.

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