DETERMINANTS OF DEMAND FOR FRESH VEGETABLES IN THE SLOVAK REPUBLIC

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ABSTRACT

Vegetables are among the most important foods because of the health benefits of eating them. The main objective of this paper is to investigate the effect of income, own price and price of other vegetables on the demand for vegetables in the Slovak Republic. Descriptive statistics and regression analysis are used for the analysis. The data are drawn from the Statistical Office of the Slovak Statistical Office (2001-2019). The results of the analyses indicated that demand for lettuce (EID=3.48) and peas (EID=-4.82) responded most strongly to the change in income. The demand response to a change in the price of other vegetables was stronger than the response to a change in own price. Demand for cauliflower, and lettuce responded most strongly to the change in price of other vegetables. To increase vegetable consumption, we recommend reducing the price of complements or increasing the price of substitutes.

Introduction

Food is a key component of several fundamental dimensions of well-being, such as food security, nutrition and health. In low-income countries, they account for the largest share of total household expenditures, on average around 50% of household budgets (Egbetokun & Fraser, 2023). In the Slovak Republic, food expenditures account for approximately 20% of total net expenditures. Food consumption and expenditure on various commodities is an important area of research for economists (Felix & Kumar, 2020). Considering the similarities and differences in household food consumption behaviour, the study of household food consumption pattern is crucial (Hayat et al.,

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2023). Understanding demand patterns and their underlying determinants is important in designing food policies and informing local suppliers (Lippe et al., 2010).

There has been renewed interest in reliable estimates of food demand elasticities at the disaggregated level, not only to analyse the impact of changing food preferences on the agricultural sector, but also to identify the likely impact of price incentives on households (Ulubsoglu et al., 2016). Households are increasingly price responsive to fresh produce (Lippe et al., 2010). Cross-price and own-price elasticities have become key determinants for policy makers in making decisions on food commodity production (Naheed & Hussain, 2020). In addition to prices, consumer income is also an important determinant of demand. Evidence confirms that consumers respond to prices and income similarly in different countries of the world. Consumers in Pakistan face a different set of constraints than consumers in America. Both supply-side and demand-side factors are at work - access issues are critical, but even with better access, low income and other demand-side issues constrain vegetable consumption (Weatherspoon et al., 2015).

Vegetables play an important role for human health (Deng et al., 2023). It is one of the most important agricultural products in daily life. Due to season, supply and demand, prices fluctuate widely and there are also some substitution linkages between different types of vegetables. The demand for vegetables with strong substitutes is affected by price changes of alternative vegetables (Liu et al., 2019).

Understanding the demand for staple foods, the consumption of which ensures the health of the population, is extremely important. The demand for vegetables is influenced by the income of the population, the intrinsic price of vegetables, and the price of substitutes or complements. Very few studies have analysed the impact of the determinants of demand on the market for individual vegetables. This paper is intended to fill this gap. The main objective of the paper is to investigate the impact of income, own price and price of substitutes or complements on the demand for vegetables in the Slovak Republic. The results of the analyses can be used for nutrition and food policy makers as well as for the public.

Materials and methods

The data for the analysis are drawn from DATACUBE from SUSR, VUEPP and ATIS. The period covered was 2001-2020. The methods used were descriptive statistics and regression analysis.

Input data table

Variable	Unit of measure	Source
Consumption of vegetables	kg. capita^{-1}. year^{-1}	https://www.vuepp.sk/dokumenty/komodity/2021/Ovocie_zelenina_2021_07_v2.pdf https://datacube.statistics.sk/#!/view/sk/vbd_sk_win2/ps1839rs/v_ps1839rs_00_00_00_en
Price of vegetables	EUR. kg^{-1}	https://www.vuepp.sk/dokumenty/komodity/2021/Ovocie_zelenina_2021_07_v2.pdf https://datacube.statistics.sk/#!/view/sk/vbd_sk_win2/ps1839rs/v_ps1839rs_00_00_00_en
Income of habitants	EUR. year^{-1}	https://datacube.statistics.sk/#!/view/sk/vbd_sk_win2/ps1819rs/v_ps1819rs_00_00_00_en

Regression analysis was used to estimate the Marshall demand curve. The Marshall demand curve is a willingness to pay curve derived assuming all prices and incomes are constant (Hudik, 2019). The theoretical basis for the formation of demand functions has been addressed in many studies (Miyake, 2006; Gimenes-Nadal, 2018; Sprouvle, 2013, Pendakur, 2009; Lewbel & Pendakur, 2009; Smith, 2018). The Marshall elasticity compared to the Hicks elasticity provides more accurate pictures of substitutes and complements (Mustafa et al., 2022).

Based on the considerations, Marshall's model of demand for each type of vegetable was specified as a function $Q_{vi} = Q_{vi}(P_x, P_y, I)$. The demand estimator is a linear regression function which has the form:

$$Q_{vi} = \alpha + \beta_1 P_{vi} + \beta_2 I + \beta_n P_{jn} \quad (1)$$

Where:

Q_{vi} – demand for i-th type of vegetable in kg. capita^{-1}. year^{-1}

$\alpha, \beta_1, \beta_2, \beta_n$ – estimated regression parameters

P_{vi} – price of i-th type of vegetable in EUR.kg^{-1}

I- income of inhabitant in EUR.capita^{-1}. year^{-1}

P_{jn} price of j-th type of vegetable in EUR.kg^{-1}

$$E_{ID} = \beta_2 \frac{I}{Q_{vi}} \quad (2)$$

Where:

E_{ID} – income elasticity of demand in %

$$E_{PD} = \beta_1 \frac{P_{vi}}{Q_{vi}} \quad (3)$$

Where:

E_{PD} – own-price elasticity of demand in %

$$E_{CPD} = \beta_n \frac{P_{jn}}{Q_{vi}} \quad (4)$$

Where:

E_{CPD} – cross-price elasticity of demand in %

Results

As part of its disease prevention campaigns, the WHO recommends that people consume 400 g of fruit and vegetables a day. The ratio of vegetables to fruit should be 2:1, i.e. they should consume 270 g of vegetables per day. This equates to 98.55 kg per year. In 2001, the Slovak population consumed 56.2 kg per person per year. In 2019, it was already 73.4. Although the trend of vegetable consumption in Slovakia is increasing, the annual consumption of vegetables is still below the recommendations of experts. Meanwhile, the share of expenditure on vegetables ranged from 6.5 to 9.4% of total net expenditure in the period under review.

Among vegetables, Slovak consumers showed the strongest preference for tomatoes. Their average consumption was 16.17 kg per person per year (standard error 0.49, Table 1). Tomato consumption showed a relatively high standard deviation compared to other vegetables. Their consumption was scattered around the mean by 2.14 kg per person per year. The distribution of consumption is flatter than normal, right sided. Tomato consumption shows a relatively high range of values (Figure 1). The lowest tomato consumption was in 2002 at 11kg per person per year and the highest in 2018 at 18.6kg per person per year. The absolute increase in tomato consumption over the period is positive, Figure 1.

Cabbage was also strongly preferred during the period under review. Its average consumption was 15.85 kg per person per year with a standard deviation of 2.84 kg (Table 1). The distribution was more skewed than normal, left-handed. The trend in the consumption of cabbage in the Slovak Republic is downward, with considerable fluctuations. The absolute increase in cabbage consumption was negative in the period under review (Figure 1). The range of values of cabbage consumption was the highest among all vegetables, namely 12.8 kg. The minimum consumption was 12 kg per person per year in 2011. The highest consumption was at the beginning of the study period, in 2001, at 24.8 kg per person per year.

The average consumption of carrots was 10.73 with a standard deviation of 1.35. The distribution of carrot consumption was flatter than normal, right sided. The trend of carrot consumption was less fluctuating than that of the previous vegetables during the period under review. The trend in consumption was upwards, the absolute increase positive. The range of values was medium, 4.90 kg (Figure 1). The minimum consumption of carrots, 8 kg per person per year, was recorded in 2001. The highest consumption of

carrots by Slovak consumers was in 2019, at 12.8 kg per person per year.

Onion was one of the preferred vegetables among Slovak consumers. Its average consumption was 8.77 kg per person per year in the period under review (Table 1). Onion consumption was in a flatter than normal distribution, left-handed. The trend of its consumption was slightly increasing, with considerable fluctuations. The absolute increase in onion consumption was positive. The standard deviation was among the medium ones. Consumption differed from the average by 1.31 kg in the period under review. The range of values was 4.30 kg (Figure 1). The minimum consumption in 2002 was 7.1 kg per person per year. The highest consumption of onions was recorded in 2013 at 11.4 kg per person per year.

The average consumption of cucumber during the study period was 7.23 kg per person per year with a standard deviation of 1.69 (Table 1). Its distribution was more pointed than normal, right skewed. The range of values was relatively quite high, 6.1 kg (Figure 1). The lowest consumption of cucumbers was in 2002, at 3.5 kg per person. The highest consumption was recorded in 2009, at 9.6 per person. The trend in cucumber consumption was upward, with one significant short-term increase in 2009. The absolute increase in cucumber consumption was positive over the period under review.

The average consumption of peppers was 6.18 kg per person per year with a standard deviation of 1.19 kg during the period under review. The distribution of pepper consumption was flatter than normal, right-sided. Pepper consumption was on an increasing trend over the period with one significant increase in 2006. The range of values was 4.10 (Figure 1). The lowest consumption of pepper per capita per year was 3.6 in 2003 and the highest consumption was 7.7 kg per capita per year in 2016. The absolute increase in consumption over the study period was positive.

Cauliflower had an average consumption of 3.22 during the period under study (Table 1). The standard deviation was 0.58 kg. The distribution was flatter than the normal distribution, right-handed. The range of values was 2.20 kg, the absolute increase in cauliflower consumption was negative over the study period. The lowest consumption of cauliflower in the Slovak Republic was recorded in 2019 at 3.5 kg and the highest in 2008 at 4.5 kg. The trend of cauliflower consumption was slightly decreasing.

Table 1. Results of descriptive analysis of consumption of selected vegetables in kg. capita^{-1}.year^{1}

	Mean	Standard Error	Median	Standard Deviation	Kurtosis	Skewness	Confid. Level (95.0%)
Peas	0.75	0.07	0.80	0.29	-0.73	-0.26	0.14
Celery	1.36	0.12	1.40	0.53	-0.13	0.53	0.26
Carrots	10.73	0.31	11.20	1.35	-0.92	-0.35	0.65
Parsley	2.24	0.09	2.20	0.39	-0.14	0.45	0.19
Onion	8.77	0.30	8.50	1.31	-0.46	0.65	0.63
Tomatoes	16.17	0.49	17.00	2.14	0.76	-1.23	1.3

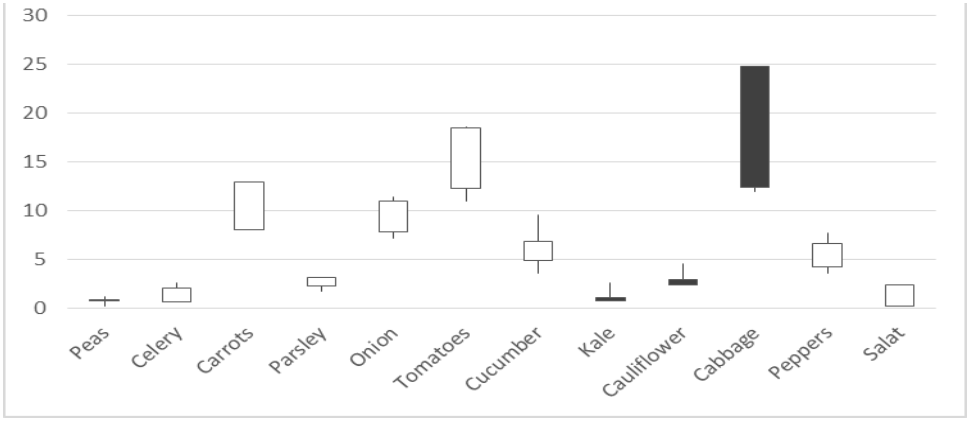
	Mean	Standard Error	Median	Standard Deviation	Kurtosis	Skewness	Confid. Level (95.0%)
Cucumber	7.23	0.39	7.70	1.69	0.14	-0.99	0.82
Kale	1.57	0.11	1.50	0.49	0.11	0.64	0.24
Cauliflower	3.22	0.13	3.40	0.58	-0.45	0.35	0.28
Cabbage	15.85	0.65	15.70	2.84	4.78	1.68	1.37
Paprika	6.18	0.27	6.50	1.19	-0.21	-0.90	0.57
Salat	1.31	0.15	1.50	0.63	-0.68	-0.31	0.31

Source: own calculations

The average consumption of parsley was 2.24 kg per person per year during the period under review. Actual consumption was scattered around the average by 0.39 kg. The distribution of consumption was flatter than normal, left-handed. The range of values was lower, 1.4 kg. The lowest consumption of parsley, 1.40 kg per person per year, was recorded in the highest consumption was in the year and it was 3.10 kg per person per year. The absolute increase in consumption was positive (Figure 1).

The lowest average consumption in the period under review was for kale (1.57 kg per person/year), celery (1.36 kg per person/year), lettuce (1.31 kg per person/year) and peas (0.75 kg per person/year). The standard deviation was also the lowest for these vegetables. The consumption of celery and lettuce had a positive absolute increase during the period under review. The distribution of both types of vegetables was flatter than normal. The distribution of lettuce was right-handed, that of celery left-handed. Consumption of cabbage and peas had a negative absolute increase. The distribution of both these vegetables was flatter than normal, left-handed. The difference between maximum and minimum consumption was highest for lettuce and celery (Figure 1).

Figure 1. Measures of variability of consumption of selected vegetables (2001-2019) in kg. capita^{1}. year^{1}



Source: own calculations; * the negative absolute increment is marked in black

Estimation of demand functions

The impact of own price, price of other goods and consumer income on the demand for individual vegetables was investigated using Marshall demand functions. Tables 2, 3 provide a glimpse of the basic tests of estimation by regression analysis and the estimated coefficients.

Table 2. Regression analysis results for the estimation of Marshall demand functions I.

Price (P), Income/demand for vegetable	Peas	Celery	Carrots	Parsley	Onion		Tomatoes
R square	0.73	0.78	0.80	0.78	0.78		0.80
F calc.	18.70	64.79	1132.79	71.08	60.51		406.92
P Peas	-1.23	-2.01	1.84	0.93	-10.95		5.15
P Celery	1.1	11.57	36.27	3.41	-37.66		53.47
P Carrots	6.18	2.83	40.62**	0.70	-4.54		67.48**
P Parsley	0.50	-2.99	-31.36**	-5.17	24.18		-55.15*
P Onion	-4.87	-5.34	-33.27***	5.22	6.7		-61.84**
P Tomatoes	-1.77	-2.18*	-9.25****	-2.28	1.40		-6.84
P Cucumb.	3.53	0.08	0.97	0.57	13.52		-4.05
P Kale	2.37	-14.94**	-27.13**	-6.27	-14.43		-65.76**
P Caulif.	0.02	11.48	24.01*	9.58	4.53		38.51
P Cabbage	-4.00	-2.30	-1.50	2.50	-27.93		49.12**
P Paprika	4.56	-2.09	3.67	-3.87	5.75		-6.52
P Salat	0.78	0.81	8.01***	0.32	-0.96		13.74**
Income	-0.01****	0.00	0.01***	0.00	0.00		0.04***

*P<0.15; ** P<0.10; ***P<0.05; ****P<0.01

Price in EUR.kg^{-1}, Income in EUR.capita^{-1}.year^{-1}, Quantity in kg.capita^{-1}.year^{-1}

Source: own calculations

The index of determination for each vegetable species ranged from 0.73 to 0.80. . Thus, the models explained a sufficiently high variability in the demand for different vegetables. F calculated was higher than F tabulated at 0.05 level of significance in all models. Thus, according to Fisher's test, the selected models explained the variation in demand for individual vegetables with 95% confidence. The results of the Student's test are shown in the table for each of the estimated coefficients through the α significance level. When estimating the demand for parsley and onions, the coefficients for the effect of own prices, prices of other vegetables, and the effect of income were not statistically significant. Demand for peppers, cucumbers and peas were characterized by statistically significant coefficients being estimated only for the effect of income on demand. Demand for celery was significantly influenced by the price of tomatoes and the price of kale. Demand for carrots was the most affected by prices of other vegetables. The coefficients

were significantly estimated for the price impact of carrots, parsley, onions, tomatoes, kale, cauliflower and lettuce. The income of residents also had a significant effect on the demand for carrots. The price of carrots, parsley, onions, cantaloupe, kale, cabbage, and lettuce had a significant effect on the demand for tomatoes. The effect of income was also significant. Only the price of cabbage significantly affected the demand for kale. The demand for cauliflower was significantly influenced by the prices of several types of vegetables. These were the prices of peas, carrots, parsley, onions, tomatoes and lettuce. The demand for cabbage was significantly affected by the price of peppers, the demand for lettuce and the price of carrots, in addition to income. The estimated coefficients, which were reliable, are further used to calculate elasticities (Table 4).

Table 3. Regression analysis results for the estimation of Marshall demand functions I.

Price (P), Income/demand for vegetable	Cucumbers	Kale	Cauliflower	Cabbage	Paprika	Salat
R square	0.79	0.74	0.79	0.77	0.79	0.79
F calc.	145.68	20.60	105.32	37.56	151.79	111.82
P Peas	-2.51	8.26	22.90***	72.06	4.41	-5.34
P Celery	7.75	-19.40	33.03	260.54	0.51	-12.13
P Carrots	-11.99	-10.28	26.15*	63.73	4.39	-11.41**
P Parsley	2.66	13.66	-29.72**	-110.79	-0.83	9.00
P Onion	-0.67	-0.47	-21.61*	-11.98	-3.41	4.67
P Tomatoes	2.33	0.84	-5.43***	-7.50	3.61	1.00
P Cucumb.	-19.66	8.33	-6.37	-83.90	-10.02	0.98
P Kale	-2.63	18.36	-20.27	-153.39	-8.37	2.6
P Caulif.	-5.97	-13.12	20.74	171.88	-0.77	-5.13
P Cabbage	19.55	-14.65***	9.51	66.64	8.36	-2.38
P Paprika	-2.97	4.27	-5.48	-67.87*	-4.02	2.62
P Salat	6.53	1.59	5.68**	6.70	2.15	-0.88
Income	0.03***	0.00	0.00	-0.08**	0.02***	0.01****

*P<0.15; ** P<0.10; ***P<0.05; ****P<0.01

Price in EUR.kg^{-1}, Income in EUR.capita^{-1}.year^{-1}, Quantity in kg.capita^{-1}.year^{-1}

Source: own calculations

Impact of income on demand for vegetables

According to the estimated Marshall demand functions, Tables 2,3 and the income elasticities of demand derived from them, income was found to be a significant determinant of demand for peas, carrots, tomatoes, peppers, cucumbers, cabbage and lettuce. The change in income had a twofold effect on vegetable demand. This effect depended on which vegetables were considered by Slovak consumers to be superior and

which inferior goods. Carrots, peppers and tomatoes emerged as superior, necessary goods. When consumers' income increased, the demand for these types of vegetables would increase less than income; the income elasticity of demand for these vegetables was in the interval (0;1), Table 4. A more pronounced change would be induced by a change in income in the demand for cucumbers and lettuce. If incomeincreased, demand for these vegetables would grow faster than income. Slovak consumers considered them luxuries, their income elasticity of demand was higher than 1. The opposite effect, i.e. a decrease in demand, would be exerted by an increase in income on the demand for peas and cabbage. These vegetables were considered inferior goods by Slovak consumers. Their income elasticity of demand was less than 0. This was particularly pronounced in the demand for peas, where the income elasticity of demand took the value of -4.82.

For the demand for celery, parsley, onion, kele and cauliflower, the income of the residents was not a significant determinant, based on the P-values from Tables 2 and 3. Based on this fact, we did not calculate income elasticities of demand from the estimated coefficients for these vegetables.

The research results show that demand for seasonal vegetables such as cucumbers and lettuce responded most elastically to the change in intake. These vegetables were luxury goods during the period under study. Tomatoes, peppers and carrots emerged as essential goods. Consumption of these vegetables formed the basis of total vegetable consumption in the period under review.

Table 4. Calculated elasticities according to the estimated Marshall functions of demand

Demand for vegetable	**Determinant**	**Elasticity**[1]
Peas	Income	-4.82****
Celery	Price of tomatoes	-1.36*
	Price of kale	-3.45**
Carrots	Price of carrots	1.61**
	Price of parsley	-1.74**
	Price of onion	-2.08***
	Price of tomatoes	0.08****
	Price of kale	-0.79**
	Price of cauliflower	1.25*
	Price of salat	0.89***
	Income	0.36***

Demand for vegetable	Determinant	Elasticity[1]
Tomatoes	Price of carrots	1.78**
	Price of parsley	2.03*
	Price of onion	-2.56**
	Price of kale	-1.27**
	Price of cabbage	0.63**
	Price of salat	1.02**
	Income	0.83***
Cucumber	Income	1.37***
Kale	Price of cabbage	-1.93***
Cauliflower	Price of peas	1.74***
	Price of carrots	3.46*
	Price of parsley	-5.50**
	Price of onion	-4.50*
	Price of tomatoes	-1.43***
	Price of salat	2.11**
Cabbage	Price of peppers	-2.80*
	Income	-1.81**
Peppers	Income	0.62***
Salat	Price of carrots	-3.73**
	Income	3.48****

Source: own calculations

*P<0.15; ** P<0.10; ***P<0.05; ****P<0.01

[1] Only elasticities with a confidence level greater than 85% were selected

Impact of own prices and prices of other vegetables on the demand for vegetables

By deriving own price elasticities and cross price elasticities of demand, we investigated the impact of prices on the demand for different types of vegetables.

Based on the P values in Tables 2 and 3, demand for no vegetable except carrots responded significantly to the change in own price. Therefore, only the price elasticity of demand for carrots was quantified.

The price of parsley affected the demand for cauliflower the most, followed by the demand for tomatoes and carrots. When the price of parsley increased by 10%, the demand for cauliflower decreased by 55% and carrots decreased by 17.4% (Table 4). These vegetables act as a complement. The opposite effect was induced by the price increase of parsley in the demand for tomatoes (increase of 20.3%) (Table 4). Slovak

consumers substituted these vegetables for each other. Demand for this vegetable responded elastically to the change in the price of parsley.

Demand also responded elastically to the change in the price of onions, which was particularly evident in the demand for carrots, tomatoes and cauliflower. All these vegetables acted as a complement to onions. If the price of onions increased by 10%, the demand for cauliflower would decrease by 45%, the demand for tomatoes by 25.6%, and the demand for carrots by 20.8%.

The price of carrots affected the demand for tomatoes, cauliflower and lettuce. Cauliflower and tomatoes acted as substitutes; lettuce acted as complements. A 10% increase in the price of carrots would cause the largest change in the demand for lettuce, which would decrease by 37.3%. The demand for cauliflower would increase by 34.6% along with a 10% increase in price, the demand for tomatoes would increase by 17.8%. Vegetable demand responds elastically to a change in the price of carrots. The price of carrots also has a statistically significant effect on the demand for carrots. However, the positive correlation between the two is not consistent with economic theory, , which assumes a negative correlation between price and quantity demanded. In practice, however, a positive price elasticity of demand is often encountered. This result can be interpreted as meaning that the population does not react to a rise in the price of carrots, probably because this vegetable is one of the staple vegetables of almost daily consumption.

The change in the price of cauliflower and peppers also responded elastically to the change in the demand for vegetables. When the price of cauliflower increased by 10%, the demand for carrots increased 12.5%. Slovak consumers would substitute this vegetable for cauliflower if its price increased. For peppers, the complement was cabbage. A 10% increase in the price of peppers would reduce the demand for cabbage by 28%.

Demand for vegetables reacted less strongly to the change in the price of other vegetables. The price of lettuce influenced demand for cauliflower, tomatoes and carrots. A 10% increase in the price of lettuce would increase demand for cauliflower by 21.1%, demand for tomatoes by 10.2% and demand for carrots by 8.9%. In response to a 10% increase in the price of kale, demand for celery would decrease 34.5%, demand for tomatoes would decrease 12.7%, and demand for carrots would decrease 7.9%. The price of tomatoes influenced the demand for celery, kale and carrots. With a 10% increase in the price of tomatoes, demand for kale decreased by 14.3%, demand for celery decreased by 13.6% and demand for carrots increased by 0.8%. The price of cabbage influenced the demand for tomatoes and cabbage. With a 10% increase in the price of cabbage, the demand for tomatoes increased by 6.3% and the demand for kale decreased by 19.3%. The price of peas influenced the demand for cauliflower and lettuce. With a 10% increase in the price of peas, the demand for cauliflower increased by 17.4%

The results of our research on cross-price elasticities show that different vegetables have both substitution and complementary links between them, which are mainly conditioned by dietary habits and the way in which meals are prepared. An example of this is onion vegetables, which are complementary to other vegetables, as they are mainly used in Slovak cuisine to flavour other vegetable dishes. Many substitute vegetables are tomatoes, which are also often used as a side dish for other dishes. Substitutes for tomatoes are, for example, cabbage, lettuce, or carrots or parsley, whose uses are very similar.

Discussion

Some studies confirm the non-elliptical behaviour of consumers to change the own price of individual foods. A study in Mexico, based on own price elasticity, found that 11 of the 12 products analysed reached values less than 1, i.e. demand for them is inelastic (Tinoco et al., 2011). Studies in Pakistan have similar results. The results of the compensated own price elasticities show that eight groups of food commodities have inelastic own price elasticities. This implies that these food commodities are an integral part of household diets (Hayat et al., 2023). Marshall elasticity results indicated that vegetable consumption in Pakistan is the least sensitive to own price change among all the commodities studied (Milojević et al., 2020; Naheed & Hussain, 2020). The findings of expenditure elasticity (uncompensated own price elasticity) show that vegetables and pulses are common (inelastic) goods while meat and fruits are luxury (elastic) goods (Mustafa et al., 2022). The price elasticity of 11 vegetables is negative. It shows that if the price of vegetables decreases, the total turnover in the vegetable market will increase due to the increase in the number of purchases (Liu et al., 2019). Demand for organic vegetables is price elastic as well as expenditure elasticities. Demand for conventional vegetables in the US is primarily inelastic (Kasteridis & Yen, 2012). Demand for vegetables in Tamil Nadu was elastic. The compensated own price elasticity in Tamil Nadu showed that nuts and oil in rural and urban households, meat in rural households and milk, eggs, vegetables and fruits in urban households were elastic to price change (Felix & Kumar, 2020). Our findings indicated that the demand of the Slovak population for different types of vegetables is not statistically significantly related to the own prices of vegetables. The only exception was the demand for carrots. Given the positive correlation between price and quantity demanded of carrots, we can infer a willingness to purchase this staple vegetable regardless of the change in its price.

According to the available research results on income elasticity of demand, vegetables are generally perceived as both a necessity and a luxury good. The results of income elasticities show that milk, meat and fruits are luxury foods. Non-essentials are cereals, pulses, vegetables, sugar and ghee. (Hayat et al., 2023). Income elasticity revealed that food group, milk and vegetables are essential goods in rural households but luxury goods in urban households (Felix & Kumar, 2020). If spending increases, consumers will increase their demand for organic vegetables faster than their demand for conventional vegetables (Schröck, 2013). Income elasticity results in our research

indicate that carrots, peppers and tomatoes are superior goods for Slovak consumers, cucumbers and lettuce are luxury goods, and peas and cabbage are inferior goods.

The cross-price elasticities appear to be asymmetric. Demand for organic vegetables is more sensitive to price changes of conventional vegetables than vice versa (Schröck, 2013). From the results of the uncompensated cross-price elasticity, consumers substitute vegetables with meat and vegetables with fruits. They purchase pulses together with vegetables and with meat (Mustafa et al., 2022). Ther is a mixture of gross substitution and complementarity among vegetable products, but the dominant pattern is pure substitution (Kasteridis & Yen, 2012). In terms of cross price elasticity and using green vegetables as an example, the cross-price elasticities between green vegetables and the following vegetables are positive, which means that the existing price elasticity between green leaves and the following vegetables substitution relationship: root vegetables, Chinese cabbage, kale, legumes, beetroot, mushrooms. The cross-price elasticity between green leaves and the following vegetables is negative, which means the existence of a complementary relationship between green leaves and solanaceous, allium, yam vegetables and buds (Liu et al., 2019).

Similarly, our research results indicated several substitution and complementary relationships in the vegetable market. Most of them were observed in the market for carrots and tomatoes, which are among the most consumed vegetables in Slovakia. Substitutes to tomatoes were, for example, cabbage, lettuce, carrots and parsley. The cross-price elasticity between the prices of these vegetables and the demand for tomatoes was positive. There was a negative price elasticity between the prices of onions and kale. These vegetables were complementary to tomatoes.

Conclusion

The aim of the paper was to investigate the impact of income and prices on the demand for vegetables in the Slovak Republic. The composition of demand for vegetables was relatively stable over the period under study. The highest demand was for tomatoes, cabbage, carrots and onions. The trend in the consumption of most vegetables was increasing over the period under review. Cabbage, together with kale, cauliflower and peas, had a decreasing trend in consumption.

Demand for each type of vegetable responded to the change in incomein varying degrees. Demand for carrots, peppers and tomatoes, which were considered essential goods by Slovak consumers, was less elastic. A more pronounced response to the change in incomewas observed in the demand for more luxurious vegetables such as cucumbers and lettuce and for inferior vegetables such as peas and cabbage.

Based on the fact that the coefficients quantifying the relationship between own price and demand for each type of vegetable were not statistically significant, it can be argued that demand depends more on the prices of other types of vegetables than on own price.The demand for cauliflower was the most elastic to changes in the price of other vegetables, which was influenced significantly by the price of parsley (ECPD=-5.50),

the price of onions (ECPD=-4.50) and the price of carrots (ECPD=3.46). Demand for lettuce was strongly influenced by the price of carrots (ECPD=-3.73). Demand for carrots, which is one of the most preferred vegetables in Slovakia, was the least elastic to the change in prices of other vegetables. The price of carrots, together with the price of parsley and onions, was among the significant determinants of demand for most vegetables.

Every country's nutrition and food policy seek a high consumption of fruit and vegetables. Regarding the consumption of vegetables such as lettuce, which has the lowest average consumption, it can be increased, for example, by increasing the income of the population or by lowering the price of carrots, which are a complement to lettuce for Slovak consumers. Further research in this area could aim to find out how consumers from different socio-economic backgrounds react to the vegetable market.

Conflict of interests

The authors declare no conflict of interest.

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