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Fiscal reform in Costa Rica

Price elasticities of major food categories to inform decision-making

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Abstract

In the context of fiscal reform in Costa Rica (value added tax revision), the definition of a new basic tax basket – *canasta básica tributaria* (CBT), incorporating nutritional criteria is underway in the country. In this study, price elasticities of major food categories were analysed using a Quadratic Almost Ideal Demand System (QUAIDS) model and data from the 2018 National Survey of Household Income and Expenditures – *Encuesta Nacional de Ingresos y Gastos de los Hogares* (ENIGH). Measuring price elasticities is essential because it allows: knowing the extent to which food demand reacts to price changes, anticipating changes in the quantities demanded as a result of fiscal policy changes, measuring potential substitution and complementary effects between food groups, and potential nutritional effects of fiscal policies. As a result, it helps to provide recommendations on the content of a CBT with nutritional criteria. Results show that the food categories with the most elastic demand are “bread and cereals”, “mineral waters, soft drinks and juices” and “milk, cheese and eggs”. Substitution effects exist between the following groups: “fruits” and “oils and fats”, “fruits” and “bread and cereals”, and between “milk, cheese and eggs” and “oils and fats”. For this last food category and for the one which includes sweets and chocolates, the consumption decreases when the price of “bread and cereals” increases. They are complementary goods. These relations between food groups need to be considered when defining a national CBT with nutritional criteria, and with the objective of promoting the consumption of healthier food groups while disincentivizing the consumption of the unhealthy ones. Lastly, it is important that the consumption of the healthiest foods within each food group be fiscally promoted.

Keywords: value added tax, basic tax basket, price elasticity, nutrition, Costa Rica.

JEL codes: D12, H3, I18.

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1 Introduction

Costa Rica does not escape the double burden of hunger and malnutrition (overweight and obesity) in Latin America. Although the country has been successful in the fight against malnutrition, 5.4 percent of the population remains food insecure (FAO, IFAD, UNICEF, WFP and WHO, 2020). Extreme poverty is stagnant at 5.8 percent of the population, and poverty at 21 percent for over 15 years (INEC, 2020). At the same time, according to the 2009 National Nutrition Survey, an alarming 64.5 percent of the adult population is affected by overweight or obesity, with rates reaching 66.6 percent among women and 62.4 percent among men. Children and adolescents are another group significantly impacted: according to the 2016 School Census, approximately 34 percent of the school population is affected by overweight and obesity.

The country is in the process of implementing a tax reform that includes the review and modification of the value added tax (VAT). With the approval of the "*Ley de Fortalecimiento de las Finanzas Públicas"* (No. 9635) by the Legislative Branch in December 2018, different criteria have been established to tax foods in a differentiated manner. Products listed in the basic tax basket – *canasta básica tributaria* (CBT) would be taxed at 1 percent VAT, while the rest of the products would be taxed at 13 percent. The products encompassed within the CBT are established by a Presidential Decree and refers to the food items that are predominantly consumed by the first quintile of the population, according to the 2013 National Survey of Household Income and Expenditures (INEC, 2013). Subsequently, on 4 December 2020, Law No. 9914 called *"Definición de la Canasta Básica por el Bienestar Integral de las Familias"* was approved. The law stipulates that the CBT shall consist of the most consumed products by the 30 percent of households with the lowest income, and "will value the inclusion of foods of high nutritional value, based on criteria such as the implementation of a balanced and diverse diet that meets the nutritional needs, culturally relevant and derived from the epidemiological profile of the population" (Law No. 9914).

This last point is fundamental given that international evidence indicates that lower-income households often choose foods with a lower cost per calorie, such as those high in sugars, fats, and sodium, while consuming fewer foods with a higher cost per calorie, such as fruits and vegetables (Mayén *et al.,* 2014). Consequently, the introduction of VAT and the definition of a CBT without nutritional criteria may widen the gap between the costs of foods of low nutritional value and foods of high nutritional value, negatively impacting access to nutritionally desirable foods for the entire population and, particularly, for the lower-income population.

This can have socially undesirable consequences. On the one hand, it can create a vicious circle of poor nutrition by reinforcing low-quality diets, especially among the most socially vulnerable population. On the other hand, it can generate changes in poverty profiles if the composition of the CBT is not taken into account. Finally, indirectly incentivizing unhealthy diets can increase the development of noncommunicable diseases in the medium and long term (Rauber *et al.* 2018; Park and Yu, 2019; Mullee *et al.,* 2019). Thus, it is necessary to elaborate basic tax baskets that incorporate nutritional criteria and reject the approach of elaborating baskets that barely cover the minimum nutritional requirements, disregarding the broader aspects of the right to food. According to the recommendations of the Institute of Nutrition of Central America and Panama (INCAP) for the elaboration of basic food baskets, it is necessary to include locally produced foods with high nutritional content and reject the inclusion of

industrialized foods with low nutritional value and high caloric content. In this context, it is crucial that the CBT aligns closely with this reality.

In the case of Costa Rica, a study conducted by Vargas and Elizondo (2015) analysed the price elasticity[1] of food demand, identifying two groups of foods: those whose demand is inelastic (quantity demanded reacts less than proportionally to price changes) and those whose demand is elastic (quantity demanded reacts more than proportionally to price changes). The findings suggest that implementing taxes on high-calorie, low-nutrient products, such as soft drinks and cookies, could significantly reduce the consumption of these foods.

Knowing the extent to which food demand reacts to price changes makes it possible to anticipate changes in the quantities demanded as a result of fiscal policy changes (e.g. introduction of excise taxes or changes in VAT). It also allows measuring potential substitution and complementary effects between food groups, and the nutritional effects of fiscal policies. It is particularly relevant for the case of Costa Rica since the content of the CBT is currently under discussion and would incorporate a nutritional component for the selection of food products.

In this study, we estimate income[2] and price elasticities (uncompensated)[3] of different food groups for Costa Rican households using the *Encuesta Nacional de Ingresos y Gastos de los Hogares 2018* (INEC, 2018) and using a Quadratic Almost Ideal Demand System (QUAIDS) model. Price elasticities estimated from demand system models such as QUAIDS are key elements to measure the impact of fiscal policies on household spending for specific food groups. The objective of this work is to generate technical and reliable information for fiscal policy decision-making to promote actions to facilitate the consumption of healthier foods, especially in population with social vulnerability, and under the progressive approach of the current government. The results of this study could be used to redesign or evaluate current fiscal policies related to food and beverage consumption.

[1] The price elasticity of demand reveals how much the quantity demanded for a good or food (or category of food) varies with changes in its price.

[2] Income elasticity of demand reveals how much the quantity demanded for a good or food (or food category) varies with changes in consumers' income levels.

[3] Uncompensated price elasticity takes into account the influence of prices and income on utility maximization, compensated price elasticity only prices.

2 Methodology

2.1 Data sources

The 2018 National Survey of Household Income and Expenditures – *Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH)* (INEC, 2018) conducted by the National Institute of Statistics and Census (INEC) was used to estimate the model and the elasticity calculations. The cross-sectional survey collects household-level information on spending on different goods and services (expenditures and quantities), as well as socioeconomic and demographic information on 7 046 households. It is used to elaborate the Consumer Price Index, basic food baskets, to define poverty and perform other consumption/socioeconomic analyses. The survey is representative of six different regions covering Costa Rica. The information was collected between February 2018 and March 2019 for 36 weeks and over ten-day periods. For the purpose of this study, all food and beverage product records are taken into account with the exception of donations, obtaining a final sample of 6 972 households. Donations have been eliminated because they do not represent any purchase decision by the individual based on a certain price.

2.2 Variables

Eleven food and beverage groups were used for this study. The food and beverage groups used in this study are based on the Classification of Individual Consumption According to Purpose (COICOP) (in Spanish: *Clasificación del Consumo Individual por Finalidades* [CCIF]), because they correspond to large-food categories that we are interested in analysing. The COICOP is a classification of household consumption expenditures that national statistical offices have developed on their own and have used in various analytical applications (United Nations, 2001). They are sufficiently large categories to obtain reliable price and income elasticities, and sufficiently disaggregated to observe complementarities and substitutions between groups according to potential price and/or income changes. COICOP groups are used rather than nutritional groups in order to give an economic balance representing an individual's consumption. Foods are already classified according to the COICOP classification in the ENIGH 2018 (INEC, 2018). Table 1 shows the list of categories with the respective codes.

Table 1. Classification of Individual Consumption According to Purpose categories

Classification of Individual Consumption According to Purpose category (COICOP)	COICOP code
Bread and cereals	0111
Meat	0112
Fish	0113
Milk, cheese and eggs	0114
Oils and fats	0115
Fruits	0116
Pulses and vegetables	0117
Sugar, jam, honey, chocolate and sweets	0118
Condiments	0119
Coffee, tea and cocoa	0121
Mineral waters, soft drinks, fruit and vegetable juices	0122

Source: INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares*. San José.

Food expenditure percentages were calculated for each household by summing the expenditures within each group and then dividing by the total expenditure for the 12 categories. Unit price values were calculated for each household as the ratio of expenditure to quantity for each group.

2.3 Demand analysis: Quadratic Almost Ideal Demand System and elasticity calculations

The objective of the study is to understand the sensitivity of consumers with different economic situations to price changes, producing elasticities that report this sensitivity. To do so, we estimate a Quadratic Almost Ideal Demand System (QUAIDS) using Stata v.16.1. This model allows us to assess the extent to which demand reacts to price and income variations, hence allowing to anticipate variations in quantities demanded as a result of potential changes (e.g. the introduction of taxes or changes in the VAT rate). More details about the model can be found in Annex 1.

2.4 Endogeneity and missing values

A proportion of households do not report purchases of the food and beverage categories we considered. This may be due to different reasons such as: the household does not consume these types of products or simply did not do so in that reference period of the survey. In fact, the ENIGH was not conducted for the purpose of this analysis in particular. It is used to elaborate the Consumer Price Index, basic food baskets, to define the poverty line as well as other consumption/socioeconomic analyses. Due to this reason, depending on the specific decade under consideration, there are households that report consuming various food categories while others do not. Nevertheless, this situation remains valuable as the reports balance each other out and enable the execution of the aforementioned studies.

Nevertheless, the ENIGH is the only source of information in Costa Rica with timely and current data on food quantities and expenditures. It has been proven that income and expenditure surveys are a tangible and reliable option to develop this type of analysis if the data is analysed cautiously.

It is possible to implement a specific methodology to take into account this issue of missing values (biased parameter estimates). Cohorts can be created to group households and have complete information for a certain defined number of groups. This methodology has been used by Mendoza-Velázquez (2017). In our case, 200 groups were created from the income variable (net, current, per capita and without rental value) of the database. This method reduces data variability, but it gives elasticities that better represent the totality of households, and not only the households that report consuming more food categories, which in general have similar sociodemographic characteristics.

This aggregation of households also mitigates the endogeneity problems that naturally exist in these demand systems: the unit values are calculated using other variables of the system (expenditures and quantities per food category); hence they are endogenous. The consequence is that the obtained expenditure percentages may depend on other factors. The creation of 200 income groups should generate reliable average unit values for each group, smoothing out the variations that may exist in food quality as well.

3 Results

Table 2 presents general sociodemographic descriptive data. Results will also be presented by deciles of net current income per capita (without rental value) for the first two deciles and first three deciles of the population. Results are presented in this way because the basic food basket in Costa Rica is usually based on the consumption patterns from the first two deciles of the population in terms of income.

Table 2. Household demographic characteristics (6 972 households)

Deciles	2 first deciles	3 first deciles	7 other deciles	Total sample
Number of households	1 661	2 433	4 539	6 972
Average monthly expenditure	$1.99x10^7$	$2.14x10^7$	$3.49x10^7$	$3.02x10^7$

Notes: Deciles of net current income per capita (and without rental value). Average expenditure per month is expressed in 2020 CRC (CRC 615.2 = EUR 1). Weighted values.

Source: Author's own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

Tables 3, 4 and 5 show the percentage of households reporting consumption in each category, the average expenditure per food group and the average unit values in the different decile groups. The percentage of households reporting expenditure greater than zero allows us to identify which food categories are the most consumed by households and enables us to evaluate the problem of missing values.

Table 3. Descriptive statistics of consumption by Classification of Individual Consumption According to Purpose category

Deciles	Two first deciles (1 661 obs.)	Three first deciles (2 433 obs.)	7 other deciles (4 539 obs.)	Total sample (6 972 obs.)
Category	**Households reporting expenditure > 0**			
Bread and cereals	1 562	2 288	4 216	6 504
Meat	1 175	1 730	3 252	4 982
Fish	659	965	1 894	2 859
Milk, cheese and eggs	1 351	1 979	3 831	5 810
Oils and fats	965	1 385	2 091	3 476
Fruits	589	943	2 596	3 539
Pulses and vegetables	1 351	1 986	3 665	5 651
Sugar, jam, honey, chocolate and sweets	1 192	1 700	2 779	4 479
Condiments	1 016	1 443	2 437	3 880
Coffee, tea and cocoa	953	1 365	1 951	3 316
Mineral waters, soft drinks, fruit and vegetable juices	842	1 268	2 581	3 849

Notes: Deciles of net current income per capita (and without rental value). Households reporting expenditure > 0 (6 972 households). Weighted values.
Source: Author's own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

The category "fish" has the lowest percentage of households reporting purchases, followed by "coffee, tea and cocoa". On the contrary, 93.2 percent of households report buying "bread and cereals", and 83.2 percent "milk, cheese and eggs". There is a pronounced difference in fruit consumption between the first two deciles of the population (35.5 percent) and the last seven (57.2 percent). “Fish" is the group with the highest average unit value per gram, followed by: "coffee, tea and cocoa"; "condiments"; "sugar, jam, honey, chocolate and sweets" and "meat".

Table 4. Descriptive statistics of consumption by Classification of Individual Consumption According to Purpose category: average expenditure (6 972 households)

Deciles	Two first deciles (1 661 obs.)	Three first deciles (2 433 obs.)	7 other deciles (4 539 obs.)	Total sample (6 972 obs.)
Classification of Individual Consumption According to Purpose	Average expenditure (% of total food expenditure)			
Bread and cereals	24.88	24.42	20.38	21.37
Meat	16.76	17.06	17.80	17.63
Fish	4.06	3.98	4.76	4.57
Milk, cheese and eggs	13.73	14.0	14.97	14.69
Oils and fats	4.12	3.87	2.75	3.03
Fruits	3.27	3.81	7.61	6.68
Pulses and vegetables	12.27	12.54	13.08	12.99
Sugar, jam, honey, chocolate and sweets	6.73	6.38	4.85	5.21
Condiments	5.21	4.98	5.38	5.26
Coffee, tea, cocoa	4.85	4.73	3.26	3.63
Mineral waters, soft drinks, fruit and vegetable juices	4.21	4.21	4.86	4.70

Notes: Deciles of net current income per capita (and without rental value). Average expenditure per month is expressed in 2020 CRC (CRC 615.2 = EUR 1). Weighted values.

Source: Authors’ own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

Table 5. Descriptive statistics of consumption by Classification of Individual Consumption According to Purpose: unit values (6 972 households)

Deciles	Two first deciles (1 661 obs.)	Three first deciles (2 433 obs.)	7 other deciles (4 539 obs.)	Total sample (6 972 obs.)
Classification of Individual Consumption According to Purpose	**Average unit values for 100 grams**			
Bread and cereals	157	161	223	201
Meat	295	298	367	343
Fish	547	556	618	597
Milk, cheese and eggs	202	201	214	210
Oils and fats	147	152	206	184
Fruits	139	142	161	156
Pulses and vegetables	124	122	131	128
Sugar, jam, honey, chocolate and sweets	230	242	421	353
Condiments	429	426	471	454
Coffee, tea, cocoa	458	472	654	579
Mineral waters, soft drinks, fruit and vegetable juices	87	90	96	94

Notes: Deciles of net current income per capita (and without rental value). Average expenditure per month is expressed in 2020 CRC (CRC 615.2 = EUR 1). Weighted values.

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

Table 6 is a summary of the key values, highlighting the problem of missing values with the column "proportion of households with no consumption (percentage)", which is the percentage of households out of the total sample that do not report consuming a certain food category. For example, 59 percent of the total sample (4 113 households) do not report consuming fish and 6.71 percent (468 households) do not report consuming bread and cereals (see Table 3, households reporting expenditure > 0).

Table 6. Summary of descriptive statistics of consumption by Classification of Individual Consumption According to Purpose category (6 972 households)

Classification of Individual Consumption According to Purpose	Average expenditure (% of total food expenditure)	Average unit values for 100 grams	Proportion of households without consumption (%)	Number of missing values
Bread and cereals	21.37	201	6.71	468
Meat	17.63	343	28.54	1 990
Fish	4.57	597	59	4 113
Milk, cheese and eggs	14.69	210	16.67	1 162
Oils and fats	3.03	184	50.21	3 496
Fruits	6.68	156	50.14	3 443
Pulses and vegetables	12.99	128	18.95	1 321
Sugar, jam, honey, chocolate and sweets	5.21	353	35.76	2 493
Condiments	5.26	454	44.35	3 092
Coffee, tea, cocoa	3.63	579	52.44	3 656
Mineral waters, soft drinks, fruit and vegetable juices	4.70	94	44.79	3 123

Notes: Average expenditure per month is expressed in 2020 CRC (CRC 615.2 = EUR 1). Weighted values.

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

Tables 7 and 8 present the income and uncompensated price elasticities (own and cross-price elasticities) of the QUAIDS model. To facilitate the interpretation of the following tables, the different types of elasticities obtained are defined and explained:

- **Income elasticity:** reveals how much the quantity demanded for a good or food (or food category) varies as a percentage against percentage changes in consumers' income levels.
- **Price elasticity:** reveals how much the quantity demanded for a good or food (or food category) varies as a percentage against percentage changes in its price. There are two types of price elasticities:
  - **Uncompensated (own) price elasticity** takes into account the influence of prices and income on utility maximization.
  - **Uncompensated (cross-price) price elasticity** reveals the change in the quantity demanded for a good or food (or food category) when the price of another good, product or food category changes. This elasticity reveals whether two goods or groups of goods are complementary or substitutes.

Table 7. Income elasticities from Quadratic Almost Ideal Demand System model (6 972 households)

Classification of Individual Consumption According to Purpose	Mean	Standard deviation	Minimum	Maximum
Bread and cereals	0.99	0.002	0.98	0.99
Meat	1.00	0.001	1.00	1.00
Fish	0.97	0.012	0.91	0.99
Milk, cheese and eggs	1.01	.002	1.01	1.02
Oils and fats	1.01	.005	1.00	1.06
Fruits	1.09	.063	1.02	1.59
Pulses and vegetables	1.01	.002	1.01	1.02
Sugar, jam, honey, chocolate and sweets	0.96	0.011	0.92	0.98
Condiments	0.96	0.017	0.86	0.99
Coffee, tea, cocoa	0.92	0.033	0.73	0.97
Mineral waters, soft drinks, fruit and vegetable juices	1.07	0.021	1.03	1.16

Note: Weighted values.

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

Uncompensated elasticities were chosen because they take into account the influence of prices and income in the maximization of utility, the compensated ones only prices. Annex 2 presents the uncompensated price elasticities. The main observations on Table 7 and Annex 2 are the following:

a. Income elasticities

All elasticities have positive values, and most of them are very close to one. It means that the food categories correspond to foods that are normal goods (elasticities between zero and one). When income increases, consumption of normal goods increases in an almost proportional manner. For two categories, the elasticities are slightly higher than one: "fruits" (1.09) and "mineral waters, soft drinks and juices" (1.07). For interpretation purposes, income elasticities higher than one correspond to "luxury" categories/foods. It means that when income increases, consumption increases more than the increase in income. For the category "fruits", it means that when income increases by 10 percent, consumption increases by 10.9 percent. This holds true under the assumption of perfect price transmission, although in reality, this condition is rarely met due to various factors such as market structure, education, culinary skills of households, and time allocation, which also significantly influence consumption patterns but are often difficult to observe.

Income elasticities provide valuable insights into the influence of income on consumption patterns within specific food categories. In this case, no essential differences are observed between food categories. It is crucial to take this result into account when measuring the potential effect of fiscal policy changes. This is also why uncompensated price elasticities are more suitable for drawing conclusions. They allow us to consider the influence of prices and income on the maximization of utility, while the compensated ones only take prices into account.

b. Own price elasticities

In Annex 2, the values along the diagonal represent the own uncompensated price elasticities, whereas the values off the diagonal represent the cross uncompensated price elasticities (see next section).

All elasticities are negative. A negative price elasticity means that when the price increases, consumption decreases, i.e. there is an inverse price-quantity relationship. The most elastic categories (elasticities far from zero) are the following: "bread and cereals" (–1.19); "mineral waters, soft drinks and fruit and vegetable juices" (–1.14); "milk, cheese and eggs" (–1.03); "pulses and vegetables" (–1.00) and "meat" (–1.00). In theory, an elastic food refers to a food where the change in consumption is greater than the observed variation in price. For instance, the quantity demanded reacts more than proportionally to price changes. This is the case for the category "mineral waters, soft drinks and fruit and vegetable juices". The result means that when the price of the category rises by 10 percent, consumption decreases by 11.4 percent. A VAT of 13 percent on this food category results, for example, in a reduction in consumption of 14.8 percent. If the elasticities are equal to one, it means that the quantity demanded reacts proportionally to price changes, this is the case for the mentioned categories ("meat" and "vegetables"). For the rest of the categories, the elasticities are inelastic, especially for the following categories: "coffee, tea and cocoa" (–0.39); "condiments" (–0.41), and in a second tier "oils and fats" (–0.70). Table 8 summarizes the main results of the study (Tables 6, 7 and 8).

Table 8. Average expenditures, unit values, share of zero consumption and elasticities

Classification of Individual Consumption According to Purpose	Average expenditure (% of total food expenditure)	Average unit values for 100 grams	Proportion of households without consumption (%)	Income elasticities	Uncompensated own price elasticities
Bread and cereals	21.37	201	6.71	0.99	–1.19
Meat	17.63	343	28.54	1.00	–1.00
Fish	4.57	597	59	0.97	–0.96
Milk, cheese and eggs	14.69	210	16.67	1.01	–1.03
Oils and fats	3.03	184	50.21	1.01	–0.70
Fruits	6.68	156	50.14	1.09	–0.99
Pulses and vegetables	12.99	128	18.95	1.01	–1.00
Sugar, jam, honey, chocolate and sweets	5.21	353	35.76	0.96	–0.89
Condiments	5.26	454	44.35	0.96	–0.41
Coffee, tea, cocoa	3.63	579	52.44	0.92	–0.39
Mineral waters, soft drinks, fruit and vegetable juices	4.70	94	44.79	1.07	–1.14

Notes: Average expenditure per month is expressed in 2020 CRC (CRC 615.2 = EUR 1). Weighted values.

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

c. Cross price elasticities

Cross-price elasticities allow to identify complementarities and substitutions between groups. Table 9 shows the foods with the highest substitution ratio, i.e., substitute groups (elasticities > 0). A substitute good is a good capable of satisfying the same need as another good. When the price of such a good increase, the demand for one of its substitutes increases. A complementary good is a good which consumption level is linked to the price of another good. When the price of such a good increase, the demand for one of its complements decreases.

Table 9. Main substitutions between groups

Change in price / change in quantity	Uncompensated cross price elasticities
Bread and cereals / fruits	0.47
Fruits / oils and fats	0.36
Milk, cheese and eggs / oils and fats	0.31
Meat / fish	0.26

Note: Other groups are substitutes but the table presents the strongest relationships.

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

The results show that an increase in the price of bread and cereals contributes to an increase in fruit consumption. Similarly, the same way that when the price of fruits increases, it leads to a corresponding increase in the consumption of oils and fats; a higher price in milk, cheese, and dairy products also results in an elevated consumption of oils and fats. Additionally, when the price of meat rises, it encourages an increase in fish consumption. In all these cases, the increase in consumption is quite small (less than 10 percent). For instance, a 10 percent price increase in the "bread and cereals" category would result in a 4.7 percent increase in the consumption of fruits. It is important to take these substitutions into account because these results show that changing the price of one food category changes the consumption of others.

Regarding complementary goods, an increase in prices within the "bread and cereals" group leads to a decrease in its consumption (–1.19). Additionally, it results in reduced consumption of other food groups, such as "oils and fats" (–0.69) and "sugar, jam, honey, chocolates, and sugar confectionery" (–0.29). Indeed, the consumption of bread is usually associated to some products of these two categories. On the other hand, the consumption of fruits (0.47), fish (0.23) and milk, cheese and eggs (0.21) would increase. In general terms, these would appear to be nutritionally healthy variations. It is worth noticing that, in the event of a rise in the price of fruit, there will be a drop in its consumption (–0.99), but consumption of pulses and vegetables (–0.15) and fish (–0.32) would also slightly drop, while consumption of sugar (0.13) and oils and fats (0.32) would slightly rise. All these variations would not be very healthy in the evolution of the diet.

The price increase in the sugar group not only leads to reduced consumption of these products but also contributes to decreased consumption of oils and fats, while simultaneously increasing the consumption of fruits. Finally, it is important to mention that a rise in the price of meat would result in increased fish consumption as a substitution (0.26). Therefore, if greater fish consumption were to be encouraged, the inclusion of a smaller number of meat products in the CBT could be an alternative to be considered. The increase in the price of meat would also lead to a reduction in the consumption of soft drinks and juices (–0.27).

4 Discussion

The findings align with results from other studies conducted in Latin America, particularly regarding the following categories: "mineral waters, soft drinks, fruit and vegetable juices"; "fruits"; "milk, cheese and eggs"; "meat"; "sugar, jam, honey, chocolate and sweets" and "fish". For the category "bread and cereals", we found a more elastic result than the literature. Variations in the estimates may arise due to factors such as the model specifications (AIDS or QUAIDS), the food groups elected and/or by the data used (sample size, chosen demographic variables).

Comparing the results with the Vargas and Elizondo (Vargas and Elizondo, 2015) study in particular, we have similar results except for the categories "meat" and "fish". In their study, the results are less elastic. The study also calculates elasticities based on the ENIGH in Costa Rica but does not use a QUAIDS model and presents different food groups than those presented in this study. This may explain the differences obtained. Meat and fish are comparatively expensive foods, and therefore we find more elastic price elasticities. Similarly, the categories "milk, cheese and eggs" and "vegetables" are more elastic in our study. It means that the consumption of vegetables can be encouraged by a decrease in their price. On the contrary, the category "sugar, jam, honey, chocolate and sweets" is less elastic in this study. This information confirms that in order to discourage the consumption of this type of food, a more complete nutritional strategy should be articulated, including public campaigns, advertising bans, education, among others. Besides, an additional increase in the taxation of unhealthy products such as soft drinks would reduce the current high consumption rates. In this study and others, soft drinks have an elasticity greater than one, which means that the effect of a higher price on consumption would be significant. The greater the price elasticity of a food, the more effective it is to reduce its consumption by increasing its price (taxes, VAT increase, etc).

Table 10 presents the results obtained in similar studies. When the categories were different, the results of the studies were averaged to correspond to the groups used in this study. Not all studies look at all the categories incorporated in this paper.

Table 10. Uncompensated price elasticities

Classification of Individual Consumption According to Purpose	Present study	Vargas and Elizondo (2015)	Caro *et al.* (2017)	Nimanthika Lokuge *et al.* (2019)	Mendoza-Velázquez (2017)	Caro *et al.* (2018)
Country	**Costa Rica**	**Costa Rica**	**Colombia**	**Sri Lanka**	**Mexico**	**Chile**
Bread and cereals	–1.19	–1.00	–0.85	–0.67	–0.46	–0.67
Meat	–1.00	–0.65	–0.84	–1.30	–0.49	–1.13
Fish	–0.96	–0.30		–0.98		–1.10
Milk, cheese and eggs	–1.03	–0.85	–0.94	–0.98		
Oils and fats	–0.70	–0.95			–0.58	
Fruits	–0.99	–0.80	–0.96	–0.80		
Pulses and vegetables	–1.00	–0.70	–0.96	–0.80	–0.7	

Classification of Individual Consumption According to Purpose	Present study	Vargas and Elizondo (2015)	Caro *et al.* (2017)	Nimanthika Lokuge *et al.* (2019)	Mendoza-Velázquez (2017)	Caro *et al.* (2018)
Country	**Costa Rica**	**Costa Rica**	**Colombia**	**Sri Lanka**	**Mexico**	**Chile**
Sugar, jam, honey, chocolate and sweets	–0.89	–1.00	–0.80			–0.80
Condiments	–0.41		–1.01			
Coffee, tea, cocoa	–0.39	–0.50	–1.35			–1.37
Mineral waters, soft drinks, fruit and vegetable juices	–1.14	–1.10	–1.62			–1.00

Note: Elasticities are significant at p <0.05.

Source: Authors' own elaboration based on data from INEC (2018), Vargas and Elizondo (2015), Caro *et al*. (2017), Mendoza-Velázquez (2017), and Caro et al (2018).

We identified that there was substitution between the "fruits" category and two other categories: "oils and fats" and "bread and cereals". For example, if one wants to promote increased fruit consumption, it is advisable to maintain affordable prices, thereby avoiding a shift in consumption towards "oils and fats" and simultaneously consider raising the price of bread and cereals. This result makes sense because the unit values of fruits and oils and fats are quite similar, also with the unit value of pulses and vegetables. Nevertheless, it can be intuited that consumption is shifted towards more oils and fats because they are more convenient foods to eat and cook with (current lifestyles). There is a preference for consuming foods from the "bread and cereals" category when the price of fruits increases, as these foods are highly favoured and widely consumed in Costa Rica. There is also substitution between the "milk, cheese and eggs" category and the "oils and fats" category. For example, if we wanted to increase the consumption of milk, cheese and eggs, we would have to keep their prices sufficiently low. The tendency is to replace these higher-priced fats with more affordable alternatives from the "oils and fats" category.

Substitution effects between food categories are important elements when constructing a CBT with nutritional criteria, as they determine whether the CBT can ultimately have positive effects on health. In the context of the Complementary Basic Basket (CBT), this would imply that in order to encourage fruit consumption and prevent a shift towards increased consumption of oils and fats, one possible approach could be to restrict the inclusion of products from the "bread and cereals" category in the basket. It is necessary to carefully choose the products from this category that will be part of the basket, based on nutritional and/or food security criteria. On the contrary, more fruits should be included in the CBT for positive health effects. As suggested by the analysis, a rise in the price of "bread and cereals" also leads to a decrease in oils, fats and sweets consumption, which induces a general positive impact on health.

5 Conclusion

The inclusion of nutritional considerations in the definition of any fiscal measure related to food products is crucial. This is because the proven impact of price fluctuations on food choices directly affects the health of the population. By integrating nutritional perspectives, fiscal measures can better promote healthier food choices and contribute to improved public health outcomes. The inclusion or removal of products from the CBT has nutritional and public health effects, and it is essential that these are taken into consideration when selecting the CBT.

It is important to encourage the consumption of particularly healthy food groups such as fruits, pluses and vegetables to promote healthier diets. The consumption of fruits, pulses and vegetables can be significantly encouraged through price reductions and, for example, reduced VAT. A greater number of these types of products in the CBT will be an indicator of its healthy character. It is important at the same time to discourage the consumption of particularly unhealthy food groups such as sugar-sweetened beverages and the group of sugar, jam, honey, chocolate and sweets with fiscal measures (VAT increase and/or excise taxes), but also with other complementary measures (public campaigns, banning of advertisements, education, among others), since we observed the consumption of some of these products was not strongly elastic to price changes. Moreover, excise taxes and changes in VAT must be reflected in the goods consumption prices, so that they can have an impact on consumption. This is another important feature that must be guaranteed by governments if they want to notice tangible effects of these taxes on food patterns.

Finally, it is crucial to prioritize fiscal promotion of the consumption of the healthiest foods within each food group. Being more nutritionally selective when choosing products to be included in the basic food basket is essential due to the negative impact some food products can have on the overall diet. In this regard, effects of substitution and complementarity between food groups must be considered. This study offers a notable illustration of substitutions and complementarity, particularly in relation to the food group "bread and cereals”.

This study provides recommendations for the design of the CBT with nutritional criteria in Costa Rica, and more generally demonstrates the importance of elasticity analysis on food products consumption when it comes to designing fiscal reforms regarding food products. Other governments seeking to enact and implement similar reforms in their own countries could consider revisiting the policy recommendations regarding food taxes outlined in this paper.

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Annex 1. Quadratic Almost Ideal Demand System model

The model is as follows (Banks *et al.,* 1997):

$$w_i = \alpha_i + \sum_{j \in I} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{m}{a(p)}\right) + \frac{\lambda_i}{b(p)} \left(\ln\left(\frac{m}{a(p)}\right)\right)^2 \quad \forall\, i \in I$$

$$\ln a(p) = \alpha_0 + \sum_{j \in I} \alpha_j \ln p_j + \frac{1}{2} \sum_{l \in I} \sum_{j \in I} \gamma_{lj} \ln p_l \ln p_j$$

$$b(p) = \prod_{j \in I} p_j^{\beta_j}$$

Where:

w_i y p_i are the expenditure and price percentages for food category i;

m is the total food expenditure per household;

I represents all the food categories (in this case 11);

α_i , γ_{ij}, β_i y λ_i are the parameters to be estimated.

According to Deaton and Muellbauer (1980), linear restrictions on the parameters are necessary for the model to correspond to the economic theory of demand. They are the following:

$$\sum_{i \in I} \alpha_i = 1, \sum_{i \in I} \beta_i = 0, \sum_{i \in I} \lambda_i = 0, \sum_{i \in I} \gamma_{ij} = 0 \quad \forall\, i \in I$$

$$\sum_{j \in I} \gamma_{ij} = 0 \quad \forall\, i \in I, \gamma_{ij} = \gamma_{ji} \quad \forall\, i, j \in I \text{ (symmetry}^4\text{)}$$

$$\sum_{i \in I} \rho_{ik} = 0 \quad \forall\, k \in K \text{ (zero-degree homogeneity on prices}^5\text{)}$$

Finally, the demand system must be equal to 1, since the expenditure shares must add up to 100 percent (these are percentages of expenditure over total expenditure):

$$\sum_{i \in I} w_i = 1$$

[4] The substitution or complementarity effects between food categories are symmetrical (direction and magnitude).
[5] If prices and income change in the same way, quantities demanded are not affected.

Total food expenditure, being highly correlated to income, is used in the model to calculate income elasticities. The elasticities (income and price) were calculated for the mean values of the variables. They can be estimated from the following equations (μ_iy μ_{ij}):

$$\mu_i = \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)} \ln\left(\frac{m}{a(p)}\right)$$

$$\mu_{ij} = \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} \ln p_k\right) - \frac{\lambda_i \beta_j}{b(p)} \left(\ln\left(\frac{m}{a(p)}\right)\right)^2$$

Income elasticities can be obtained from the following expression:

$$\varepsilon_i = \frac{\mu_i}{w_i} + 1$$

The uncompensated price elasticities are given by the following equation:

$$\varepsilon_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}$$

Other methods commonly used are Almost Ideal Demand System (AIDS) models. The advantage of QUAIDS is that, unlike AIDS, it allows greater flexibility in the income and expenditure curves (Engel curves). It means that it allows the inclusion of a non-linear expenditure function.

We assumed weak budget separability, therefore modelling the total demand for food at home, divided in eleven groups. We used the expansion factors in order to take into account the survey design in our estimates.

Annex 2. Uncompensated price elasticities from the Quadratic Almost Ideal Demand System model (6 972 households)

Change in quantity	Change in price										
	111	112	113	114	115	116	117	118	119	121	122
111	–1.1878722	0.07627355	0.04708748	0.13859468	–0.09955099	0.1337758	–0.02400962	–0.07027901	–0.00694228	–0.03999459	0.04634192
112	0.09322565	–0.99994276	0.06476562	–0.13698653	0.01141682	–0.01238999	0.05895604	–0.02532486	0.02278568	–0.0067876	–0.06698431
113	0.22851064	0.2584827	–0.96299248	–0.27791837	0.04832681	–0.32175703	0.00955154	0.05467815	–0.02392643	0.13366723	–0.11953102
114	0.20748456	–0.16621397	–0.08437272	–1.0265419	0.06522687	0.02504299	0.02395997	0.05102094	–0.07421837	–0.06522345	0.03190351
115	–0.69440555	0.06500356	0.06920808	0.30609847	–0.70481225	0.362719	0.12063956	–0.30426408	–0.19383522	–0.08049022	0.04590794
116	0.46542351	–0.03621565	–0.22932589	0.06174753	0.18062742	–0.98897858	–0.31320211	0.11477697	–0.16228658	–0.17558979	0.01244048
117	–0.04080109	0.08045028	0.0027774	0.02805348	0.02918873	–0.15073681	–1.000235	0.02234143	–0.06825009	0.06745814	0.0180704
118	–0.28592963	–0.0833606	0.04663341	0.13740433	–0.17787481	0.13307626	0.05459323	–0.89055765	0.09084706	–0.06715348	0.07515819
119	–0.03072146	0.07747932	–0.02005572	–0.20798006	–0.11528919	–0.19248388	–0.16663543	0.09097873	–0.41113043	0.0207857	–0.00734187
121	–0.23606634	–0.03133475	0.16010972	–0.25818156	–0.06768546	–0.2935999	0.23690898	–0.09833821	0.02970481	–0.39224743	0.01784429
122	0.15529041	–0.26676074	–0.14127637	0.14074497	0.03677334	0.11202594	0.08080266	0.04990058	–0.05189906	–0.04049113	–1.1373773

Source: Authors' own elaboration based on data from INEC. 2018. *Encuesta Nacional de Ingresos y Gastos de los Hogares.* San José.

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