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Understanding consumption patterns of vulnerable Costa Rican households through price and income elasticities in food

Entendiendo los patrones de consumo de los hogares vulnerables costarricenses a través de las elasticidades de precio e ingreso en alimentos

Erick Sequeira-Benavides [1], *Juan-Rafael Vargas* [2] & *Yanira Xirinachs-Salazar* [3].

Abstract: This study examines food consumption patterns in Costa Rica by estimating the income and price elasticities of food products among vulnerable households. Using data from the Encuesta Nacional de Ingresos y Gastos de los Hogares for 2004, 2013, and 2018, it applies a DLQ equation model with Cragg's method to address zero expenditures. Unlike previous studies, which have primarily focused on broader economic sectors, this research provides a product-level analysis while also examining changes over time and emphasizing low-income households. The findings reveal that most food products are perfectly inelastic in both income and price, indicating that vulnerable households do not adjust their food consumption despite economic fluctuations. As a result, they absorb the impact of rising prices or declining incomes, at the expense of other essential goods and services. These rigid consumption patterns highlight structural economic constraints and reinforce the need for policies that mitigate the adverse effects of economic shocks on food security and poverty reduction**.**

Keywords: income elasticity, price elasticity, consumption patterns, food security, poverty.

Resumen: Este estudio examina los patrones de consumo de alimentos en Costa Rica mediante la estimación de las elasticidades ingreso y precio de los productos alimenticios entre los hogares vulnerables. Utilizando datos de la Encuesta Nacional de Ingresos y Gastos de los Hogares para 2004, 2013 y 2018, aplica un modelo de ecuaciones DLQ con el método de Cragg para abordar los gastos cero. A diferencia de estudios anteriores, que se han centrado principalmente en sectores económicos más amplios, esta investigación proporciona un análisis a nivel de producto, al tiempo que examina los cambios a lo largo del tiempo y hace hincapié en los hogares de bajos ingresos. Los resultados revelan que la mayoría de los productos alimentarios son perfectamente inelásticos tanto en ingresos como en precios, lo que indica que los hogares vulnerables no ajustan su consumo de alimentos a pesar de las fluctuaciones económicas. En consecuencia, absorben el impacto del aumento de los precios o la disminución de los ingresos, a expensas de otros bienes y servicios esenciales. Estos rígidos patrones de consumo ponen de manifiesto las limitaciones económicas estructurales y refuerzan la necesidad de políticas que mitiguen los efectos adversos de las crisis económicas sobre la seguridad alimentaria y la reducción de la pobreza.

Palabras clave: elasticidad ingreso, elasticidad precio, patrones de consumo, seguridad alimentaria, pobreza.

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1. Introduction

Understanding how food consumption responds to changes in income and prices is essential for assessing household expenditure patterns and economic resilience. Food income and price elasticities quantify this relationship by measuring the degree to which food consumption changes in response to variations in income or price. Specifically, demand elasticity is calculated as the percentage change in the quantity of food demanded divided by the percentage change in income or price. These measures provide valuable insights for policymakers and the food industry, as they help anticipate shifts in demand and their broader social implications, enabling more informed decision-making.

The study of income and price food elasticities is particularly relevant in a globalized economy, where food security and affordability remain pressing challenges due to factors such as unequal resource distribution, market volatility, and income disparities. A better understanding of these dynamics is necessary to design policies that ensure access to affordable food and protect vulnerable populations from economic shocks. These issues are central to global efforts to reduce poverty and hunger, as outlined in the United Nations' Sustainable Development Goals (SDG). In particular, this study aligns with the objectives of eradicating poverty and improving food security, reinforcing the need for economic measures that mitigate food insecurity and enhance household resilience.

Research in food elasticities has suggested that policies targeting food affordability can positively impact households' quality of life (Andreyeva et al., 2008; Powell & Chaloupka, 2009; Kumar et al., 2011; Skoufias et al., 2015; Guerrero et al., 2017; Blakely et al., 2020). Some studies have examined food elasticities across different contexts, shedding light on consumption patterns and household responses to economic changes. Cornelsen et al. (2014) analyzed cross-price elasticities from 78 studies across 38 countries, finding that food consumption is most sensitive to price changes in low-income regions, particularly for staple foods such as cereals. Clements and Si (2015), using data from the International Comparison Program, found that while income effects are small, low-income households are more responsive to price fluctuations. More recently, Bouyssou et al. (2024) analyzed animal food demand elasticities in 87 countries, showing that income elasticities for animal-based foods tend to be higher in low- and middle-income countries.

Other recent studies have further explored food elasticities, particularly in emerging economies. For example, Khoiriyah et al. (2023) examined price and income elasticities for animal-sourced foods in Indonesia, finding that fish and beef are highly price-elastic, while eggs are relatively inelastic. Similarly, Forgenie et al. (2023) analyzed urban households in Jakarta, revealing that beef and milk are luxury goods with high income elasticities, particularly among higher-income households, whereas eggs exhibit lower income elasticities. This contrast highlights how lower-income households rely more on affordable protein sources like eggs, while higher-income households shift toward more expensive animal-based foods as their incomes rise. These findings

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align with broader trends observed in low- and middle-income countries, where animal-based proteins often exhibit higher income elasticities due to their role in improving dietary quality as income increases.

In Costa Rica, elasticities have primarily been studied in relation to goods other than food. For example, Burgoin (1986) analyzed the implications of price changes in energy, Arce & Robles (2004) focused on the demand for non-tradable goods, Venegas et al. (2015) explored the potential for poverty reduction through tourism, and Ulate & Rojas (2006) examined the redistributive effects of trade policies. While policies addressing food security for vulnerable households are crucial, food elasticity analysis and estimates remain relatively scarce in the country.

Early pioneers in food elasticity analysis in Costa Rica include Geurts (1994), Lizano (1994), and Geurts et al. (1997). Following them, Elizondo et al. (2006) and Vargas & Elizondo (2015) continued the analysis for subsequent years, incorporating the quality elasticity analysis. Specifically, Elizondo et al. (2006) estimated price, income, and quality elasticities for a group of 23 food items, using Engel and demand curves through non-linear least squares since they included a quadratic income term evaluated at different income levels. Vargas & Elizondo (2015) updated the estimation, this time using ordinary least squares, but without evaluating income levels. The most recent study, conducted by Dal et al. (2022), measures income and price elasticities for food groups through cohorts, to provide recommendations on the basic tax basket.

While previous studies have laid the groundwork for understanding food elasticities in Costa Rica, particularly in the context of energy, non-tradable goods, and trade policies, there are notable gaps in the analysis of food consumption patterns, especially when focusing on vulnerable households. This study aims to address key questions such as how elasticities are classified, how consumption patterns change, and what implications variations in prices or income have on these patterns. Most existing studies have focused on broader economic sectors and have not examined food elasticities in the context of low-income households, a group highly sensitive to price and income fluctuations.

This study addresses these gaps by focusing exclusively on food elasticities for vulnerable households, using the most recent household expenditure surveys (2004, 2013, and 2018) to offer a comprehensive and up-to-date analysis of how price and income changes impact their consumption patterns over time. Unlike earlier research, this study employs the DLQ equation model and Cragg's method, which accounts for challenges such as zero expenditure observations, providing more accurate estimates of food demand. By examining three time periods, this research helps determine whether consumption patterns have evolved over time, offering valuable insights for policy design. In doing so, the study contributes to the SDG of eradicating poverty and improving food security, providing evidence to guide policies that reduce poverty and hunger among vulnerable populations.

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2. Methodology

2.1 Approach

This study employs a quantitative and empirical approach to examine how changes in prices and incomes affect the consumption patterns of food products among vulnerable Costa Rican households. Rather than analyzing the broader nutritional implications or alternative consumption choices, the focus is on determining whether these households adjust their consumption of specific food items in response to income reductions or price increases.

2.2 Data

The analysis is based on the Encuesta Nacional de Ingresos y Gastos de los Hogares (National Household Income and Expenditure Survey, or NHIES) for 2004, 2013, and 2018, conducted by the Instituto Nacional de Estadística y Censos (INEC). Each survey year consists of three datasets: expenditures, households, and individuals. The expenditure dataset provides information on quantities and spending on food items, while the household dataset includes socioeconomic and demographic characteristics. The individual dataset complements this with data on the household head. These datasets are merged to construct a comprehensive household-level dataset, containing food consumption quantities, implicit prices, and relevant household characteristics.

2.3 Food producto selection

The analysis is restricted to food products, with additional selection criteria based on the methodology used to define the basic food basket. Following Elizondo et al. (2006), two conditions must be met for inclusion: (1) the food item must be consumed by at least 20% of households, and (2) it must represent, on average, at least 0.1% of monthly household food expenditure. Applying these criteria results in a selection of 25 food items: baguette and regular bread, corn tortilla, sweet-filled cookie, rice, semi-skimmed milk, custard, chicken eggs, beef steak, ground beef, canned tuna, margarine, ripe plantain, chayote, sweet pepper, cilantro, tomato, black bean, onion, potato, sugar, bouillon powder, salt, corn tostada, ground coffee, and carbonated beverages. [4]

2.4 Households´s selection

This study focuses on estimating income and price elasticities for the most vulnerable households, requiring two methodological considerations. First, non-recurring income sources—such as transfers, in-kind wages, capital transactions, or imputed rent for owned housing—could introduce noise into the analysis. Given that expenditure more accurately reflects actual consumption patterns and is generally more reliable than self-reported income, total monthly per capita current expenditure, excluding imputed rent, is used as a proxy for income.

[4] The selection criterion is implemented for 2004, so that in 2013 and 2018 those same foods are tracked. This allows for comparison and avoids changing the food products each year. Nevertheless, two items were excluded because convergence was not achieved in the estimation method: tender cheese and powdered drinks.

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Second, a criterion is needed to define vulnerable households. In this study, vulnerability is understood in economic terms, referring to households with limited financial resources that may struggle to maintain their consumption levels when faced with income reductions or price increases. To operationalize this concept, the analysis is restricted to households whose per capita total expenditure falls below half of the median per capita total expenditure. This threshold is commonly used to approximate poverty lines, ensuring that the focus remains on households with the greatest financial constraints. After applying this criterion, the final sample consists of 937 households in 2004, 1,150 in 2013, and 1,139 in 2018, drawn from the original NHIES samples of 4,231, 5,705, and 7,046 households, respectively.

2.5 Model specification

In the literature, some of the most common models are the linear expenditure system (LES), the almost ideal demand system (AIDS), and the quadratic almost ideal demand system (QUAIDS) (Femenia, 2019). The LES, introduced by Klein & Rubin (1947) and popularized by Stone (1954), imposes three key restrictions: additivity, homogeneity, and symmetry, which are consistent with the neo-classical demand theory. However, these assumptions limit substitution flexibility, as they assume constant budget shares and positive elasticities, which prevent the possibility of inferior goods (Meyer et al., 2011). The LES is also often unsupported by empirical data (Sadoulet & de Janvry, 1995). AIDS, introduced by Deaton & Muellbauer (1980), addresses some of the limitations of the LES by allowing more flexible substitution patterns but remains constrained by linearity in logarithms, limiting the possibility for a luxury good to become a necessity or vice versa. Similar to the LES, it also imposes the same restrictions, which are often rejected empirically (Deaton & Muellbauer, 1980). The QUAIDS model, introduced by Banks et al. (1997), extends AIDS by adding a quadratic term for expenditure, overcoming the linearity limitations and offering more flexibility in estimating demand elasticities. Despite these improvements, rank-three models like QUAIDS are not necessarily superior (Meyer, 2011).

In this study, the assumptions of additivity, homogeneity, and symmetry do not hold given the characteristics of the data. In this case, as noted by Geurts et al. (1997), citing Timmer (1981) and Lizano (1994), these assumptions are rejected in empirical applications due to the nature of household expenditure data and the need for model flexibility. In this study, additivity does not hold because the expenditure shares do not sum up to total food expenditure, given that the analysis is conducted at the product level rather than a category level. Homogeneity, while a standard theoretical restriction, is often not valid in practice. Symmetry is particularly problematic, as estimating cross-price elasticities requires reciprocal substitution between products, which is not viable given that not all households consume all selected products. This would lead to a loss of observations, as missing values would need to be imputed, introducing additional noise due to implicit prices.

Although previous studies such as Khoiriyah et al. (2023) and Forgenie et al. (2023) have employed QUAIDS to estimate food demand elasticities, their analyses assumed that the restrictions of

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homogeneity and symmetry were appropriate within their respective datasets. In this study, however, these assumptions are not applicable. Given these limitations, imposing these restrictions would not be appropriate. Instead, following the approach of Lizano (1994), Geurts et al. (1997), and Elizondo et al. (2006), a double-logarithmic quadratic (DLQ) equation model is used. This model does not impose the three restrictive assumptions, and its logarithmic specification simplifies the derivation of elasticities. Thus, the DLQ model is specified as follows:

$$\ln(exp_{ih}) = \alpha_i + \beta_i \ln(x_h) + \gamma[\ln(x_h)]^2 + \delta_i \ln(p_{ih}) + \phi_i[\ln(p_{ih}) \cdot \ln(x_h)] + \lambda_i \ln(N_h) + \kappa_i \ln(CPI_h) + \mu_i z_h + \sum_{m=1}^{5} \omega_{im} r_{mh} + u_h \quad (1)$$

where exp_{ih} represents the per capita expenditure on product i for household h, x_h is the per capita total expenditure, and p_i the price of the good i. The term N_h denotes the household size, CPI_h is the general monthly consumer price index, z_h is a dummy variable indicating whether the household is in an urban (1) or rural (0) area, and r_h represents a set of dummies for the region, with Brunca as the reference region.

The use of per capita total expenditure helps account for differences in household sizes. The interaction term between price and total expenditure is included because the sensitivity of normal goods to price changes is expected to be lower at higher income levels. Household size is incorporated to correct for its relationship with per capita total expenditure. The consumer price index captures the effects of other food prices and accounts for potential seasonal price differences. Finally, regional dummies are included to control for variations in consumption patterns across different areas of the country. These variables did not receive any treatment except for logarithmic transformations. However, some expenditure and price observations are reconstructed to use all available information.[5]

2.6 Model estimation

The dependent variable includes both positive and zero values, with some food products exhibiting a relatively high number of zero expenditure observations. Using Ordinary Least Squares (OLS) in

[5] Household expenditure is divided into two categories: consumption and non-consumption. In the consumption category, some observations have negative values due to the calculation method. Specifically, for expenditures on transportation, furniture and household maintenance, and recreation and culture, household sales of goods are subtracted from total spending. When sales exceed expenditures, this results in negative consumption values. In these cases, all negative values are replaced with zero, as they do not represent actual expenditures. The rest of the expenditure components, such as food, health, and education, remain unchanged.

The database does not provide direct price information, so unit prices are used instead. These are calculated by dividing total expenditure on each item by the total quantity consumed. However, if a household did not consume a particular food product, no unit price is recorded. In such cases, the missing price is replaced by the average unit price for that item.

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this context would lead to biased and inconsistent estimates, as the error term is unlikely to have a zero mean. To account for this, a double-hurdle model is used, specifically Cragg's specification, which generalizes the Heckman selection model. This approach allows for a more flexible treatment of zero expenditures by modeling both the decision to purchase a product and the level of expenditure separately.

In the first stage, a probit regression models the probability of market participation, capturing whether a household purchases a given product during the survey period. The dependent variable is a binary indicator that takes a value of 1 for positive purchases and 0 otherwise, while the explanatory variables are those included in Equation (1). This stage estimates the Inverse Mills Ratio (IMR), which accounts for selection bias.

In the second stage, a truncated regression is estimated for positive expenditures, focusing only on those households that purchased the product. This stage corrects for selection bias by including the IMR as an additional regressor, ensuring that the estimates are not distorted by the non-random selection of purchasing households. Unlike the Heckman model, which assumes that all zero expenditures arise from non-participation, Cragg's approach allows for corner solutions, meaning that some households may choose not to purchase a product due to budget constraints rather than market exclusion. This flexibility makes the Cragg model particularly suitable for estimating food demand among low-income households, where purchasing decisions are influenced by affordability constraints and irregular consumption patterns.

Given the quadratic structure of the model, the estimation of elasticities must account for the non-linearity introduced by the expenditure term. Since per capita total expenditure is used as a proxy for income, the expenditure elasticity obtained in this study corresponds to the income elasticity of demand. To derive these elasticities, logarithmic transformations are applied, which allow for a direct interpretation of coefficients in terms of proportional changes. Specifically, the price elasticity is expressed as $\partial \ln(q_i) / \partial \ln(p_i)$, while the income elasticity is given by $\partial \ln(q_i) / \partial \ln(x_i)$.

Since expenditure on a given good is the product of price and quantity demanded, it follows that: $\ln(\exp_i) = \ln(p_i) + \ln(q_i)$.

Differentiating with respect to price and total expenditure yields:

$$\Rightarrow \quad \frac{\partial \ln(\exp_i)}{\partial \ln(p_i)} = 1 + \frac{\partial \ln(q_i)}{\partial \ln(p_i)} \qquad (2)$$

and:

$$\Rightarrow \quad \frac{\partial \ln(\exp_i)}{\partial \ln(x_i)} = \frac{\partial \ln(p_i)}{\partial \ln(x_i)} + \frac{\partial \ln(q_i)}{\partial \ln(x_i)} \qquad (3)$$

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Thus, the price elasticity is $\varepsilon = \delta + \phi \ln(x) - 1$. For the income elasticity, $\partial \ln(p_i) / \partial \ln(x_i)$ is assumed to be zero, leading to $\eta = \beta + 2\gamma \ln(x) + \phi \ln(p)$. Since both elasticities depend on a given expenditure level, the average logarithm of per capita expenditure is used for computation. Additionally, the average logarithm of the own price is used for the expenditure elasticity. Following Geurts et al. (1997), statistical significance is determined using a t-test to assess whether the elasticities are statistically different from zero.[6]

3. Results

This section presents the estimated income and price elasticities, which measure how the quantity demanded of a good respond to changes in income or price. Elasticities are classified into five categories based on their absolute value: perfectly inelastic, inelastic, unitary, elastic, and perfectly elastic. A value of zero indicates a perfectly inelastic good, meaning demand remains unchanged regardless of income or price fluctuations. Values between zero and one correspond to inelastic goods, where the percentage change in quantity demanded is smaller than the change in income or price. A unitary elasticity, which is a value of one, implies a proportional response, while values greater than one indicate elastic goods, where small changes in income or price lead to larger changes in demand. Finally, goods with an infinite elasticity are perfectly elastic, meaning any price or income change results in an extreme shift in demand. Given these classifications, the analysis first examines income elasticities, followed by price elasticities.

3.1 Income elasticities

Income elasticities are crucial for understanding the consumption patterns of vulnerable households, especially since they could be highly sensitive to income fluctuations. Table 1 shows the income elasticities for each food product across the three NHIES. Based on these results, the food products are divided into two groups according to their elasticity values: those with statistically significant elasticities, all of which are inelastic, and those whose elasticities are not statistically different from zero, which are considered perfectly inelastic.

In the inelastic group, chayote remains inelastic across all periods, indicating that its demand does not significantly respond to income changes. Similarly, corn tortillas show inelasticity in 2004 and 2013 but become perfectly inelastic in 2018, reflecting that demand for this food becomes even less responsive to income fluctuations over time. Other products, such as corn tostadas and chicken eggs, although they shift slightly in elasticity over time, still remain inelastic, suggesting

[6] For a particular elasticity *e*, the t-test statistic is: $t_e = \frac{e}{\sqrt{var(e)}}$, where $\sqrt{var(e)}$ is different for income and for price elasticity, and it is calculated as:

$$\sqrt{var(\eta)} = \sqrt{var(\beta) + 4[\ln(x)]^2 var(\gamma) + [\ln(p)]^2 var(\phi) + 4\ln(x)\, cov(\beta\gamma) + 2\ln(p)\, cov(\beta\phi) + 4[\ln(x)\ln(p)] cov(\gamma\phi)}$$

and

$$\sqrt{var(\varepsilon)} = \sqrt{var(\delta) + [\ln(x)]^2 var(\phi) + 2\ln(x)\, cov(\delta\phi)}$$

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that, regardless of income changes, vulnerable households do not significantly alter their consumption of these basic staples. This stability in demand is a clear indication that these items are viewed as necessities, with consumption largely unaffected by income variations.

Table 1

Food products income elasticities

	2004	2013	2018
Regular bread	0.88	0.57	0.53
Corn tortillas	**0.41***	**0.38***	0.50
Sweet-filled cookies	0.49	1.23	0.83
Rice	0.87	1.50	0.32
Semi-skimmed milk	0.92	1.36	1.08
Custard	0.87	1.17	0.86
Chicken eggs	0.75	0.99	**0.21***
Beef steak	0.96	1.44	0.84
Ground beef	0.80	0.84	1.03
Canned tuna	0.88	1.62	1.14
Margarine	0.37	0.49	0.64
Ripe plantain	0.51	0.61	**0.36***
Chayote	**0.26***	**0.51***	**0.36***
Sweet pepper	0.59	0.98	1.03
Cilantro	0.45	0.78	0.78
Tomato	0.75	1.28	0.89
Black beans	0.59	0.90	0.64
Onion	0.70	1.26	1.01
Potato	0.88	1.66	1.20
Regular sugar	0.78	1.18	0.66
Bouillon powder	0.63	1.29	0.98
Salt	0.40	0.78	0.49
Corn tostadas	0.67	**0.40***	**0.46***
Ground coffee	0.47	1.22	0.68
Carbonated beverages	0.66	1.65	1.80

Source: authors, based on the estimation using 2004, 2013 and 2018 NHIES.
*Note: *p < 0.05.*

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When considering income elasticities, goods are typically classified as normal or inferior. A normal good is one where demand increases as income rises, often resulting in a positive income elasticity. An inferior good, in contrast, sees demand decrease as income rises, which may lead to a negative income elasticity. For the perfectly inelastic group, however, this classification becomes irrelevant because the demand for these goods does not change with income fluctuations. Despite this, all the inelastic products in this study are considered normal goods, as they represent basic items that remain essential to the household diet, regardless of changes in income.

The perfectly inelastic group includes staple foods such as regular bread, sweet-filled cookies, rice, semi-skimmed milk, beef steak, ground beef, canned tuna, and others. For these items, demand remains constant regardless of income changes, highlighting their essential role in household diets. These goods are considered normal inelastic goods, as their demand does not diminish even as household income increases.

As these goods are perfectly inelastic, and although some exhibit slight elasticity, an increase in income would likely lead to a reallocation of spending toward discretionary items. However, in general, their consumption remains constant regardless of economic shifts. These goods are seen as essential and fundamental to the household diet. Items such as bread, rice, and eggs are considered staples that households rely on for daily nutrition, making them less responsive to income changes. Consequently, vulnerable households tend to maintain their consumption levels even when faced with lower incomes. This behavior suggests a lack of flexibility in household budgets, as these essential items could have few substitutes.

The inelastic nature of these foods indicates that households are unable to significantly reduce their consumption of basic staples, even when facing income constraints. However, if income were to increase, rather than purchasing more of these same goods, households might prioritize improving their diet by shifting to higher-quality or more diverse food options. From a policy perspective, this suggests that while price interventions on staple foods are crucial to protecting vulnerable households during economic downturns, complementary strategies should also focus on improving access to nutritious and diverse food options. Given the limited ability of these households to adjust their consumption patterns, any intervention that enhances the affordability of essential foods while promoting dietary quality could have a substantial impact on their well-being.

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3.2 Price elasticities

Table 2

Food products price elasticities

	2004	2013	2018
Regular bread	-0.59	1.97	**-0.38***
Corn tortillas	-1.08	**-0.26***	**0.02***
Sweet-filled cookies	-1.76	-1.48	-0.77
Rice	-1.52	-4.58	-6.05
Semi-skimmed milk	-1.90	-4.05	-1.62
Custard	-2.22	**-0.04***	-2.00
Chicken eggs	-2.23	**0.28***	0.69
Beef steak	-4.43	-5.81	-3.59
Ground beef	-4.65	-3.35	-5.19
Canned tuna	-0.96	-2.35	**0.06***
Margarine	-4.73	-0.90	-1.45
Ripe plantain	-3.16	-1.15	-2.87
Chayote	-1.22	-1.34	**-0.17***
Sweet pepper	-1.11	**-0.24***	-0.84
Cilantro	-1.40	-1.37	-1.32
Tomato	-1.28	-1.92	-0.88
Black beans	-3.05	-2.63	-1.16
Onion	0.92	-0.30	-0.50
Potato	-0.81	-1.75	-1.35
Regular sugar	**-0.17***	3.06	6.73
Bouillon powder	**0.23***	-0.25	5.07
Salt	-2.40	-3.11	-0.53
Corn tostadas	-1.58	-1.86	-2.98
Ground coffee	-3.80	-6.79	-3.45
Carbonated beverages	0.66	1.65	1.80

Source: authors, based on the estimation using 2004, 2013 and 2018 NHIES.
*Note: *p < 0.05.*

Table 2 presents the price elasticity estimates for each food product across the three NHIES. Based on these results, the food products are classified into three groups: those with statistically significant negative price elasticities, which follow the expected inverse relationship between price and quantity demanded; those with statistically significant positive price elasticities, which

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contradict the expected pattern and suggest that higher prices are associated with increased demand; and those whose price elasticities are not statistically different from zero, which are considered perfectly inelastic.

The negative price inelastic group includes products that exhibit the expected inverse relationship between price and quantity demanded: as prices increase, consumption decreases, although at a proportionally lower rate. This pattern is observed in items such as corn tortillas, sweet peppers, and custard in 2013, as well as bread and chayote in 2018. However, despite being statistically significant, these elasticities remain relatively low, indicating that households continue purchasing these products even when prices rise. The limited response to price increases suggests that these foods are essential and lack close substitutes within household budgets, forcing consumers to absorb price changes rather than adjust their consumption significantly.

The positive price elasticities observed for some products, such as corn tortillas, canned tuna and chicken eggs, present a less intuitive result, as it implies that an increase in price leads to an increase in the quantity demanded. In 2004, bouillon powder is the only food product with a positive price elasticity, but in the following years, it becomes perfectly inelastic. In 2013, chicken eggs are the only positive price elasticity item, which then becomes perfectly inelastic. In 2018, corn tortillas and canned tuna are the only positive price elasticity food products; however, while this relationship contradicts the expected inverse demand pattern, the observed elasticities are close to zero, indicating that the demand for these products remains relatively stable even with price changes.

Possible explanations for these positive elasticities include substitution within food categories, where households may switch to these products if other similar items become more expensive; seasonal effects, where consumers may stock up on certain products ahead of price increases; or perceived quality changes, where higher prices might be associated with better quality, leading consumers to increase demand.

The perfectly inelastic group encompasses the majority of food products analyzed. Items such as rice, semi-skimmed milk, beef steak, ground beef, black beans, potatoes, and salt show no statistically significant response to price changes, indicating that their demand remains stable regardless of price fluctuations. This lack of sensitivity suggests that these foods are deeply ingrained in household consumption patterns, and households prioritize maintaining their consumption levels even in the face of rising prices. This behavior is particularly relevant for vulnerable households, as it highlights their limited ability to adjust spending when faced with cost increases. Instead of reducing their consumption of these staples, they may be forced to cut back on other non-essential goods or shift expenditures within their food basket.

3.3. Consumption patterns and the inflationary tax

When food prices rise but wages do not increase at the same rate, households experience a decline in their purchasing power. This effect is often referred to as an inflationary tax, as it reduces

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the real value of money, forcing consumers, especially low-income households, to absorb the rising cost of necessities without an equivalent increase in income (Fields, 2015). Unlike a direct tax, this burden is not explicitly imposed by the government but results from macroeconomic conditions where essential goods become more expensive relative to household earnings.

This effect was particularly evident throughout 2022, a year marked by rising inflation. For instance, in August 2022, the second-largest monthly increase in the price level for food and non-alcoholic beverages was recorded (INEC, 2022). This peak was part of broader inflationary pressures stemming from the expansionary policies implemented during the COVID-19 pandemic, which had initially aimed to support economic recovery but later contributed to rising consumer prices. Given the inelastic nature of these goods, these households have limited ability to substitute them or adjust their consumption patterns to offset the impact of rising prices.

Most of the analyzed food products are also perfectly inelastic in income, meaning that even when income decreases, their consumption remains unchanged. If household income is insufficient to meet all basic needs, families are forced to reallocate spending, prioritizing food at the expense of other essential goods and services. This is particularly concerning for lower-income households, which allocate a higher share of their income to food consumption (INEC, 2019). Such trade-offs may have significant consequences, as expenditures on healthcare, education, or other long-term investments in well-being could be compromised, potentially reinforcing cycles of poverty. While Costa Rica provides public healthcare and education, indirect costs such as transportation, school supplies, and opportunity costs still pose financial burdens, particularly for the most vulnerable. This is concerning, as access to healthcare and education has been shown to have a positive impact on quality of life (Guisan & Expósito, 2010).

Consequently, these foods are necessities that households continue to purchase regardless of changes in their income and prices, which may significantly affect their quality of life. Households bear the full impact of price increases or income reductions, often at the cost of other needs. Therefore, these results highlight key policy considerations. Policymakers should evaluate mechanisms to mitigate the impact of rising food prices, whether through price stabilization programs, targeted subsidies, or direct income support. Additionally, while Costa Rica has mechanisms such as minimum wage adjustments, it is essential to assess whether these periodic increases are sufficient to offset the rising cost of essential goods.

Existing policies aimed at protecting low-income households, such as the basic tax basket, already offer reduced VAT rates (1% instead of 13%) for essential food products, but further measures could be considered. Enforcing and expanding school meal programs to provide multiple meals per day could help reduce the financial strain on vulnerable families. Additionally, cash transfer programs targeting low-income households could be strengthened by improving coverage, adjusting benefits for inflation, enhancing targeting mechanisms to ensure they reach those most

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in need, and streamlining bureaucratic processes through digitalization. Finally, complementary initiatives such as food vouchers or coupons could further support food security efforts.

International evidence suggests that well-targeted cash transfer programs, food assistance initiatives, and school meal programs can effectively mitigate the impact of rising food prices and income fluctuations on vulnerable households. Conditional cash transfer programs, such as Familias en Acción in Colombia and Bolsa Família in Brazil, have been shown to increase food consumption and improve dietary quality among low-income households, particularly for protein-rich foods and staple goods (Attanasio & Mesnard, 2006; Hoddinott & Wiesmann, 2008; Soares et al., 2010). Similarly, food voucher programs and direct food transfers have helped stabilize consumption patterns and reduce food insecurity in Latin America, even during economic downturns (Hidrobo et al., 2016; Morales-Ruán et al., 2013). School feeding programs, such as those implemented in Mexico and Brazil, have ensured access to nutritious meals for children, alleviating financial pressure on low-income families and contributing to food security (Sidaner et al., 2013; Mundo-Rosas et al., 2018).

The results of this study show that most of the analyzed products are perfectly inelastic, meaning that vulnerable households bear the full impact of price increases or income reductions on their consumption of staple foods. As a result, they must reduce spending on other goods and services to maintain their food intake. This underscores the need for policies that alleviate financial pressure on food expenditures, particularly during periods of economic instability. When food prices rise, price stabilization mechanisms or food assistance programs can help prevent severe trade-offs between food and other essential needs. Likewise, when income decreases, cash transfer programs or targeted subsidies can provide financial relief, allowing households to maintain stable food consumption without compromising other aspects of their well-being. By incorporating these insights, policymakers can design more effective safety nets that better protect vulnerable populations from economic shocks.

4. Conclusions

In terms of income elasticity, most foods analyzed in this study are perfectly inelastic, while the rest are inelastic. This implies that, for the most vulnerable households, income fluctuations do not significantly alter their consumption of staple foods. Additionally, all goods in the sample are classified as normal, meaning that there are no inferior goods, which suggests that even if household incomes increase, spending on these staples is unlikely to decrease. Instead, higher-income households may allocate additional resources to diversifying their diets rather than increasing the quantity of these foods. On the other hand, price elasticities exhibit a similar pattern, with most foods being perfectly inelastic and the rest inelastic, reinforcing the idea that these households have little flexibility in adjusting their food consumption based on market conditions. However, a few exceptions arise, as some products, such as bouillon powder in 2004, chicken eggs in 2013, and corn tortillas and canned tuna in 2018, display positive price elasticities,

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an unexpected result that, despite being small, warrants further exploration into factors such as substitution effects, perceived quality changes, or stockpiling behavior.

The persistence of inelasticity in both price and income underscores the rigidity of consumption patterns among vulnerable households. Unlike higher-income groups, which may adjust their food choices in response to price fluctuations or increased earnings, low-income households lack the financial flexibility to do so. Their food consumption remains largely unchanged, suggesting that their dietary choices are constrained by necessity rather than preference. Furthermore, the absence of significant shifts in elasticities over the study period suggests that these consumption patterns are structural rather than temporary, reflecting long-term constraints rather than short-term economic conditions.

The lack of responsiveness in food consumption to price increases or income reductions means that vulnerable households bear the full weight of economic shocks. Since they are unable to reduce consumption of these essential goods, they must compensate by cutting expenditures on other necessary goods and services, potentially leading to a deterioration in their overall well-being. This finding is particularly relevant for policymakers aiming to address food affordability and economic vulnerability. Policies that focus solely on increasing income or lowering food prices may not be sufficient if other household expenses are severely affected. A more comprehensive approach, one that considers both direct food assistance and broader income-support mechanisms, may be required to mitigate the negative effects of economic shocks on vulnerable populations.

These findings open several avenues for future research. If households do not adjust their food consumption in response to price increases or income reductions, what other goods and services are they sacrificing instead? Do all households reduce the same types of expenditures, or does this vary depending on specific household characteristics? Further analysis could explore cross-price elasticities to identify potential substitute products, shedding light on how households reallocate their spending. Additionally, breaking down the sample into more specific subgroups could help determine whether consumption responses remain consistent across different segments of the vulnerable population.

Another relevant avenue for future research involves examining other vulnerable populations that may face different constraints in their food consumption decisions. For example, understanding the consumption patterns of rural households, informal sector workers, or households headed by single parents could provide a more nuanced perspective on food security challenges. Additionally, an important policy-oriented question is how price subsidies or targeted food assistance programs might influence household food security. Investigating whether such interventions alter consumption patterns or alleviate budgetary constraints could offer valuable insights for designing effective public policies aimed at improving food affordability and overall welfare.

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While the use of data from national household surveys across three time points provides valuable insights, several limitations should be acknowledged. Firstly, the use of cross-sectional data rather than a true panel dataset presents a challenge, as the samples change over time. Although the surveys employ random stratified sampling, which is designed to be representative of the population, the lack of continuity between survey periods means that we cannot track the same households or changes at the individual household level.

Another limitation is related to the recall bias inherent in household surveys. Participants are often asked to recall their consumption patterns, which can lead to inaccuracies, especially for consumed food products that may not have been purchased during the survey period, resulting in zero observations. The Cragg model is well-suited to handle this issue by addressing the corner solutions, but the limitation remains that some consumption behavior might be underreported. However, this bias is likely reduced by the fact that the INEC employs a grocery recording booklet, allowing households to track their expenses more accurately and reduce reliance on memory.

Finally, while the sample focuses on the most vulnerable households, which are more likely to allocate a large portion of their income to food, it is important to note that, even within this group, there may be heterogeneity in consumption patterns. However, the results are still reasonable as these households dedicate a significant portion of their income to food consumption, and their patterns of consumption are less likely to change drastically in response to variations in prices and income.

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