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Perception Matters: How Food Price Shock Perceptions Shape Household Demand Elasticities in Urban Ethiopia

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Abstract

Background: Rising food prices can constrain urban household purchasing power and influence food-allocation decisions. However, households exposed to similar market conditions may perceive food-price pressures differently, potentially reflecting heterogeneity in their food-demand responses. Despite the importance of these perceptions for understanding household economic behaviour, empirical evidence on how food-demand elasticities vary across perception-defined groups remains limited in urban Ethiopia. This study examines differences in household food-demand elasticities according to perceived food-price pressure in Addis Ababa.

Methods: A community-based cross-sectional survey of 624 households was conducted in Addis Ababa between October and December 2024. Household food expenditure and acquisition quantities were collected for 11 food commodity groups using a seven-day recall period. Households were classified into Zero-to-Medium and High-to-Very High perceived food-price pressure groups. The Quadratic Almost Ideal Demand System (QUAIDS) was employed to estimate expenditure, Marshallian (uncompensated) and Hicksian (compensated) price elasticities. Group-specific estimates were compared to assess heterogeneity in household food-demand responses.

Results: Overall, 72.1% of households reported High-to-Very High perceived food-price pressure. Monthly food expenditure accounted for 55.8% of total household expenditure, with cereals representing 66.0% of the food budget. Expenditure elasticity estimates revealed different commodity-specific patterns across perception groups. In the High-to-Very High group, expenditure elasticities were comparatively lower for meat, dairy products, vegetables and fruits, and sweets, while wheat and edible oils exhibited elasticities above unity. Formal between-group comparisons of Marshallian own-price elasticities identified statistically significant differences for eight of the 11 food groups. Price responsiveness was lower in absolute terms for teff, rice, maize, tubers and meat, but higher for vegetables and fruits, edible oils, and sweets among households reporting greater perceived price pressure. Hicksian own-price elasticity comparisons showed a similar pattern, with statistically significant differences for the same eight commodity groups.

Conclusions: Perceived food-price pressure was associated with heterogeneous patterns of household food-demand responsiveness across commodity groups. The findings highlight the importance of considering subjective price-pressure assessments alongside conventional food-demand indicators when examining urban household responses to food-market pressures. Policy responses should combine targeted social protection and staple-food affordability measures with improved access to nutrient-dense

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foods. Given the cross-sectional design, the observed differences interpreted as associations rather than causal effects.

Keywords: Food demand; perceived food-price shocks; expenditure elasticities; price elasticities; Quadratic Almost Ideal Demand System (QUAIDS); zero food expenditure; urban food security; Addis Ababa, Ethiopia.

1. Background

Food-price instability represents a major challenge to household food security, particularly in low- and middle-income countries where food accounts for a substantial proportion of household expenditure and where economic resources to absorb price increases are often limited. Although food availability is a necessary condition for food security, households' ability to acquire sufficient, diverse, and nutritious foods depends fundamentally on their purchasing power and the relative affordability of different food commodities. When food prices increase, households may respond by reducing purchased quantities, substituting relatively expensive foods with less costly alternatives, reallocating expenditure towards essential staples, or reducing purchases of nutrient-dense foods. Such adjustments can extend beyond immediate consumption decisions to affect dietary diversity, household welfare, and nutritional well-being. Understanding how households adjust their food expenditure and consumption in response to changing prices is therefore important for designing effective food-security, social protection, and nutrition-sensitive policies.

These challenges are particularly relevant in urban settings such as Addis Ababa, Ethiopia, where households depend substantially on market purchases to meet their food requirements. Unlike households with access to own-produced food, urban consumers are directly exposed to fluctuations in retail food prices and changes in the purchasing power of their incomes. When food prices rise relative to household resources, the resulting affordability constraints may disproportionately affect economically vulnerable households, whose budgets are already heavily committed to food. The consequences, however, are unlikely to be uniform across households or food commodities. Households may prioritize essential staple foods while reducing expenditure on relatively expensive or less frequently purchased food groups, potentially narrowing the diversity of their diets. Consequently, examining aggregate food expenditure alone may conceal important differences in commodity-specific demand responses and the economic adjustments households make under food-price pressure.

An important but comparatively underexplored dimension of household responses to food-price instability is the role of **perceived food-price shocks**. Although objectively measured food-price changes influence the cost of consumption, households do not necessarily experience or interpret these changes uniformly. Their perceptions may be shaped by the frequency of purchasing particular commodities, exposure to price increases in frequently purchased foods, recall of previous prices, household income constraints, expectations, and the relative importance of different food items in their consumption baskets. Research on household inflation expectations demonstrates that consumers rely substantially on their everyday purchasing experiences and grocery-price information when forming assessments of inflation. In particular, Cavallo et al. (2017) show that consumers' memories of supermarket price changes

can influence their inflation assessments, while D'Acunto et al. (2021) demonstrate that exposure to price changes in frequently purchased grocery items contributes to the formation of individual inflation expectations. Evidence from Armantier et al. (2015) further indicates that reported inflation expectations are associated with individual economic choices. Collectively, this literature establishes the relevance of subjective price assessments in understanding economic behaviour, although it does not directly demonstrate how perceived food-price pressure relates to commodity-specific food-demand elasticities in low-income urban settings.

The distinction between objectively measured food-price changes and perceived food-price pressure is therefore important for understanding household consumption behaviour. Two households exposed to similar market prices may report different levels of perceived economic pressure because of differences in purchasing power, consumption preferences, household composition, and the relative importance of particular food commodities in their budgets. Similarly, households reporting comparable perceptions may adjust their consumption differently depending on their capacity to substitute between commodities and their dependence on specific staple foods. Perceptions may therefore provide an additional analytical dimension for investigating heterogeneity in food-demand responses. However, whether households reporting different levels of perceived food-price pressure exhibit systematically different expenditure and price elasticities remain an empirical question that requires explicit investigation.

Consumer demand-system analysis provides an established theoretical and econometric framework for examining household responses to changes in prices and expenditure. The Almost Ideal Demand System (AIDS), developed by Deaton and Muellbauer (1980), offers a flexible, theoretically consistent approach to modelling expenditure allocation across commodities. Its quadratic extension, the Quadratic Almost Ideal Demand System (QUAIDS), developed by Banks et al. (1997), incorporates nonlinear Engel relationships, allowing expenditure responsiveness to vary across income or expenditure levels. This flexibility is particularly relevant to heterogeneous food-consumption settings in which expenditure responses may differ across staple foods, animal-source products, and other food categories. The framework also permits the estimation of expenditure elasticities, uncompensated (Marshallian) price elasticities, and compensated (Hicksian) price elasticities, providing complementary measures of household demand responses. Marshallian elasticities capture the combined substitution and purchasing-power effects of price changes, whereas Hicksian elasticities isolate compensated substitution responses by holding utility constant.

Empirical applications of demand-system models have generated important evidence on food-consumption behaviour in Ethiopia. Using the 2004/05 Household Income and Consumption Expenditure Survey, Tafere et al. (2010) examined household responses to changes in food prices and expenditure, documenting the importance of commodity-specific demand responses and differences between urban and rural consumption patterns. Kedir (2005), drawing on the 1994 Ethiopian Urban Household Survey, estimated own- and cross-price elasticities using household unit values and highlighted the methodological challenges associated with using expenditure-to-quantity ratios as proxies for market prices. More recently, Vigani et al. (2019) applied a QUAIDS framework to the 2015/16 Ethiopia Socioeconomic Survey and documented differences in food-demand responses across regions and expenditure groups. Their findings demonstrated that

expenditure elasticities exhibit relatively consistent patterns across regions, whereas price elasticities vary more substantially, underscoring the importance of contextual heterogeneity in food-demand analysis.

Despite these contributions, important analytical gaps remain. Existing Ethiopian food-demand studies have primarily examined aggregate, regional, or socioeconomic differences in household demand, providing limited evidence on whether demand elasticities differ systematically according to households' perceived exposure to food-price pressure. In particular, the relationship between subjective food-price assessments and the responsiveness of household demand across individual food commodities remains insufficiently understood in urban settings. This gap is important because conventional demand estimates based on average household responses may conceal differences in expenditure allocation and price sensitivity among households that experience or interpret food-price increases differently. Furthermore, the combination of high food-budget commitments, heterogeneous purchasing power, and zero expenditure observations across selected food groups makes it important to examine food demand using a flexible framework that recognizes differences in expenditure behaviour and the potential implications of non-participation in commodity purchases.

Against this background, the present study investigates the relationship between perceived food-price shock pressure and household food-demand elasticities in urban Ethiopia, using household survey data collected from 624 households in Addis Ababa between October and December 2024. The analysis considers eleven food groups and compares two perception-defined categories: households reporting zero-to-medium and high-to-very-high perceived food-price pressure. Using a QUAIDS-based demand-system approach, the study examines differences in expenditure, Marshallian own-price, and Hicksian own-price elasticities across these groups. It also describes household food-budget composition, unit-value measures, and zero-expenditure patterns, while considering the implications of demographic and socioeconomic heterogeneity for the interpretation of demand estimates.

Specifically, the study pursues three objectives:

1) To characterize household food-expenditure patterns by examining food-budget shares, commodity-specific unit values, and zero-expenditure observations across the sampled households and perception-defined groups.
2) To estimate and compare household food-demand elasticities across zero-to-medium and high-to-very-high food-price perception groups, focusing on expenditure, uncompensated (Marshallian) own-price, and compensated (Hicksian) own-price elasticities using a QUAIDS framework.
3) To examine the implications of household heterogeneity and demand-system specification for interpreting differences in estimated elasticities, including demographic and socioeconomic characteristics, zero-expenditure observations, unit-value measurement considerations, and the theoretical consistency of demand estimates.

The study makes three related contributions to the literature. First, it extends empirical food-demand analysis by introducing perceived food-price pressure as a dimension for examining heterogeneity in household demand responses. Second, it provides commodity-specific

comparisons of expenditure and compensated and uncompensated own-price elasticities, offering a more differentiated understanding of how urban households allocate food budgets and respond to price changes. Third, it generates context-specific evidence relevant to the intersection of food affordability, household economic vulnerability, and nutrition-sensitive food-security policy in urban Ethiopia.

By examining demand responses across perception-defined household groups, the study seeks to complement conventional food-demand estimates with evidence on the relationship between subjective food-price experiences and consumption behaviour. Importantly, the analysis does not treat perceived food-price pressure as an objectively measured price shock or assume that perceptions causally determine household demand elasticities. Given its cross-sectional design and observational grouping, the estimated differences are interpreted as associations that may also reflect underlying socioeconomic characteristics, consumption preferences, and purchasing constraints. The findings are therefore intended to inform a more differentiated understanding of urban food-demand behaviour and to provide empirical insights for policies aimed at protecting household purchasing power, improving the affordability of diverse foods, and strengthening urban food security.

2. Methods and Materials

2.1. Study Setting and Design

A community-based cross-sectional household survey was conducted in Addis Ababa, Ethiopia, between October and December 2024. As the country's administrative and economic capital, Addis Ababa provides an important setting for examining urban household food demand, given households' substantial reliance on commercial markets for food acquisition. The study collected information on household socioeconomic characteristics, food acquisition, food expenditure, unit values and perceived food-price pressures.

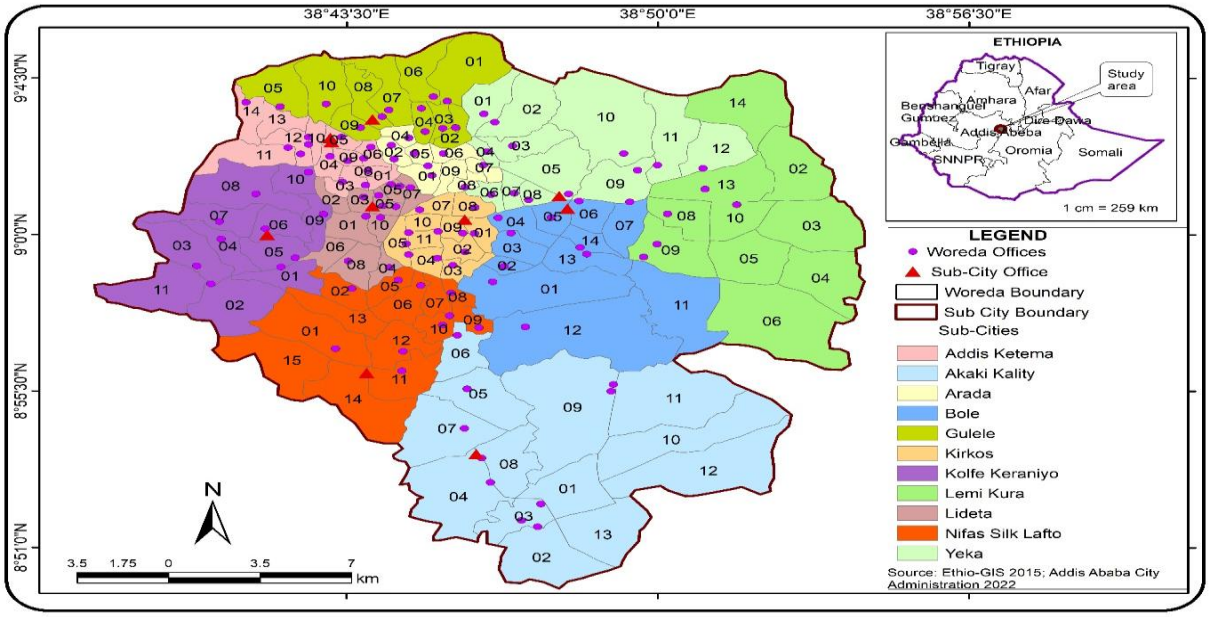


Figure 1: Map of Addis Ababa, study area. Note. Map prepared by the authors using administrative boundary data from the Addis Ababa City Administration.

2.2. Sampling Design and Sample Size

A stratified, two-stage cluster sampling design was employed to select households. The 11 administrative sub-cities of Addis Ababa constituted the sampling strata. The sampling frame comprised 264 enumeration areas (EAs) identified from the municipal register.

In the first stage, 52 EAs were selected using probability proportional to size (PPS) sampling. The selected EAs were distributed across the 11 sub-cities as follows: Addis Ketema (3), Akaki Kaliti (5), Arada (2), Bole (5), Gulele (4), Kirkos (3), Kolfe Keranio (8), Lemi Kura (5), Lideta (2), Nifas Silk Lafto (9) and Yeka (6). In the second stage, household listings were updated in each selected EA, and 12 households were selected through systematic random sampling. The sampling interval in each EA was calculated as (k=N_{EA}/12), where (N_{EA}) denotes the number of eligible households identified during the updated listing. This procedure produced a total sample of 624 households (52 EAs × 12 households).

Sample Size Estimation and Operational Design

The initial sample size was calculated using Cochran's formula for estimating a population proportion under simple random sampling (Cochran, 1977):

$$n_0 = \frac{z^2 p(1-p)}{e^2} \quad \text{(Equation 1)}$$

Where:

- n_0 is the required simple random sample size.
- $z = 1.96$ represents the standard normal critical value corresponding to a 95% confidence level.
- $p = 0.5816$ is the assumed baseline prevalence of household food insecurity, adopted from Gebre (2012) as a planning assumption rather than a measure of perceived food-price shocks.
- $e = 0.05$ denotes the absolute margin of error (precision of 5 percentage points).

Substituting these parameters into Equation 1 yields:

$$n_0 = \frac{(1.96)^2 \times 0.5816 \times (1 - 0.5816)}{(0.05)^2} \approx 373.87 \text{ households}$$

Rounding up to the nearest whole integer gives an initial requirement of 374 households.

Adjustments for Sampling Design and Population Size

1. Finite Population Correction (FPC): To account for the finite size of the target population ($N = 3{,}859{,}999$), the sample size was adjusted using the finite population correction formula:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad \text{(Equation 2)}$$

Given the large size of N, the correction factor evaluates to approximately 1.00, leaving the required sample size at 374 households.

2. Design Effect (DEFF): Because a multi-stage cluster sampling design was employed, a design effect of DEFF $= 1.5$ (sourced from Derso et al., 2021) was applied to adjust for the anticipated loss of statistical efficiency relative to simple random sampling:

$$n_{\text{cluster}} = 374 \times 1.5 = 561 \text{ households}$$

3. Non-Response Contingency and Operational Target: To buffer against potential household non-response and attrition, a 10% contingency was incorporated. Adding 10% to the clustered requirement ($561 \times 1.10 = 617.1$) yields a provisional requirement of 617 households.

To facilitate operational execution across the survey frame, the sample size was finalized at 624 households, allowing for an equal and balanced allocation of 12 households across each of the 52 designated enumeration areas ($52 \times 12 = 624$).

2.3. Data Collection and Measurement of Food Expenditure

Data were collected by trained enumerators using a structured electronic questionnaire. Household food acquisition and expenditure were recorded using a seven-day recall period across 11 mutually exclusive food commodity groups: teff, wheat, rice, maize, pulses, tubers, meat, dairy products, vegetables and fruits, edible oils, and sweets.

For each commodity group, reported weekly expenditure (x_{ih}^{w}) and acquired quantity (q_{ih}^{w}) were converted to monthly equivalents using a standard multiplier of 4.3 weeks per month ($x_{ih} = 4.3 \times x_{ih}^{w}$). Total monthly food expenditure for household h was calculated as the sum of expenditures across all 11 commodity groups:

$$X_h = \sum_{i=1}^{11} x_{ih}$$

Where x_{ih} denotes the monthly expenditure on commodity group i by household h. The resulting total monthly food expenditure served as the household-level budget constraint in the demand-system estimation. Consequently, the estimated expenditure elasticities reflect household responsiveness to changes in *total food expenditure*, rather than total household expenditure (income/total consumption).

Household budget shares were subsequently calculated as:

$$w_{ih} = \frac{x_{ih}}{X_h}, \quad \sum_{i=1}^{11} w_{ih} = 1$$

Where w_{ih} represents the proportion of total food expenditure allocated to commodity group i by household h. Households reporting no expenditure on a specific commodity group during the recall period were assigned a zero-budget share for that category.

2.4. Unit Values and Price Proxies

Commodity-specific unit values were calculated as the ratio of expenditure to the physical quantity acquired:

$$v_{ih} = \frac{x_{ih}}{q_{ih}}$$

These unit values served as household-level proxies for commodity prices in the demand-system analysis. However, unit values are not equivalent to exogenous market prices because they inherently reflect variations in product quality, packaging, purchase location, retailer choice, and household bargaining or purchasing behavior (Cox & Wohlgenant, 1986; Deaton, 1988). Consequently, they are interpreted strictly as unit-value price proxies rather than direct observations of pure market prices.

For households reporting zero expenditure and no acquisition of a specific commodity, a household-specific unit value could not be computed. To address missing price data for non-purchasing households, missing unit values were imputed using the median observed unit value for that commodity within the household's respective enumeration area. This imputation procedure allowed non-consuming households to retain a valid price entry in the price vector required for demand-system estimation. While necessary for empirical modeling, these imputed values reflect local market medians rather than household-specific choices, a distinction accounted for in the interpretation of price responses.

2.5. Measurement of Perceived Food-Price Pressure

Perceived food-price pressure was measured using household responses concerning the level of food prices at the time of the survey and/or over the preceding 12 months. For the comparative analysis, households were classified into two mutually exclusive perception groups:

1) **Zero-to-Medium perception:** households reporting food-price levels as zero/no or medium.
2) **High-to-Very High perception:** households reporting food-price levels as high or very high.

This classification was used to examine heterogeneity in estimated food-demand elasticities across households reporting different levels of perceived food-price pressure. The perception measure represents respondents' subjective assessments and should not be interpreted as a direct measure of observed price inflation or an independently measured market-price shock.

2.6. Econometric Specification: Quadratic Almost Ideal Demand System

Household food-budget allocation was analysed using the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks et al. (1997). QUAIDS extends the Almost Ideal Demand System by incorporating quadratic Engel curves, thereby accommodating nonlinear relationships between household expenditure and commodity budget shares. The model was estimated using the iterated feasible generalized nonlinear least squares (IFGNLS) procedure, following the implementation described by Poi (2012).

For commodity group i and household h, the QUAIDS budget-share equation was specified as:

$$w_{ih} = \alpha_i + \sum_{j=1}^{K} \gamma_{ij} \ln p_{jh} + (\beta_i + \boldsymbol{\eta}_i' \mathbf{z}_h) \ln \left[\frac{X_h}{m_0(\mathbf{z}_h) a(\mathbf{p}_h)}\right] + \frac{\lambda_i}{b(\mathbf{p}_h)} \left(\ln \left[\frac{X_h}{m_0(\mathbf{z}_h) a(\mathbf{p}_h)}\right]\right)^2 + u_{ih}$$

Where:

- w_{ih} is the budget share of commodity group i for household h.

- p_{jh} is the unit-value price proxy for commodity group j.
- X_h is total monthly food expenditure.

- u_{ih} is the stochastic disturbance term.
- α_i, β_i, γ_{ij}, and λ_i are structural parameters governing demand behavior.
- $\boldsymbol{\eta}_i$ captures demographic interactions within the linear expenditure term.

The translog price aggregator $a(\mathbf{p}_h)$ was defined as:

$$\ln a\,(\mathbf{p}_h) = \alpha_0 + \sum_{i=1}^{K} \alpha_i \ln p_{ih} + \frac{1}{2}\sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{ij} \ln p_{ih} \ln p_{jh}$$

And the Cobb–Douglas price aggregator $b(\mathbf{p}_h)$ as:

$$b(\mathbf{p}_h) = \prod_{i=1}^{K} p_{ih}^{\beta_i}$$

Where $K = 11$ denotes the total number of food commodity groups.

2.6.1. Demographic Expenditure Scaling

Household demographic characteristics were incorporated via an expenditure-scaling mechanism:

$$m_0(\mathbf{z}_h) = 1 + \boldsymbol{\rho}'\mathbf{z}_h$$

Where $\mathbf{z}_h$ is a vector of household characteristics and $\boldsymbol{\rho}$ is the associated parameter vector. Demographic covariates included household-head age, sex, education level, and employment status; household size; housing tenure; and household wealth status derived via principal component analysis (PCA). This specification allows the marginal budget shares to vary systematically with observed household characteristics, functioning as scaling components rather than direct additive shifts in demand.

2.6.2. Demand-Theory Restrictions

The QUAIDS model was estimated subject to the standard theoretical restrictions required for a coherent demand system:

Adding-up:

$$\sum_{i=1}^{K} \alpha_i = 1, \quad \sum_{i=1}^{K} \beta_i = 0, \quad \sum_{i=1}^{K} \lambda_i = 0, \quad \sum_{i=1}^{K} \gamma_{ij} = 0 \quad \forall j$$

Homogeneity:

$$\sum_{j=1}^{K} \gamma_{ij} = 0 \quad \forall i$$

Slutsky Symmetry:

$$\gamma_{ij} = \gamma_{ji} \quad \forall i \neq j$$

These constraints ensure theoretical consistency with consumer choice theory. Local curvature properties were assessed separately through the compensated substitution matrix.

2.7. Calculation of Demand Elasticities

Expenditure, Marshallian (uncompensated) price, and Hicksian (compensated) price elasticities were evaluated at the relevant subgroup mean budget shares using the estimated QUAIDS parameters.

Let the partial derivatives of the budget share with respect to log total food expenditure (μ_i) and log price (μ_{ij}) be defined as:

$$\mu_i = \frac{\partial w_i}{\partial \ln X}, \quad \mu_{ij} = \frac{\partial w_i}{\partial \ln p_j}$$

Expenditure Elasticity (η_i):

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

This measures the percentage change in the quantity demanded of commodity i given a 1% change in total food expenditure, holding prices constant. Values between 0 and 1 classify a commodity as a necessity, whereas values exceeding 1 indicate luxury goods.

Marshallian Price Elasticity (ε_{ij}^{M}):

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

Where δ_{ij} is the Kronecker delta (equal to 1 if $i = j$ and 0 otherwise). Marshallian elasticities capture both substitution and income effects.

Hicksian Price Elasticity (ε_{ij}^{H}):

$$\varepsilon_{ij}^{H} = \varepsilon_{ij}^{M} + \eta_i w_j$$

Derived via the Slutsky equation, Hicksian elasticities isolate pure substitution effects by neutralizing purchasing-power changes.

2.8. Assessment of Theoretical Consistency

The local curvature of the estimated demand system was evaluated by examining the

compensated substitution matrix, whose elements are given by:

$$S_{ij}^{*} = w_i \varepsilon_{ij}^{H}$$

To test for negative semi-definiteness, the matrix was symmetrized:

$$M^{*} = \frac{1}{2}(S^{*} + S^{*T})$$

The eigenvalues of M^{*} were then computed. The satisfaction of negative semi-definiteness (indicated by non-positive eigenvalues, subject to minor numerical tolerances) confirms local compliance with consumer theory curvature requirements across evaluation points, though global compliance across the entire expenditure-price space is not implied.

2.9. Comparative Analysis Across Perception Groups

Demand responses were examined across subsamples categorized by food-price shock perception groups (e.g., Zero-to-Medium vs. High-to-Very High). For each food group, the difference in estimated elasticities was evaluated as:

$$\Delta\varepsilon_i = \varepsilon_{i,\text{High/Very High}} - \varepsilon_{i,\text{Zero/Medium}}$$

Inferences regarding group differences prioritized both point-estimate magnitudes and formal statistical significance tests rather than relying solely on non-overlapping significance intervals. Because households were not randomly assigned to perception strata, these subgroup comparisons are interpreted strictly as observational differences in demand behavior rather than causal impacts of perceived price shocks.

3. Results and Discussion

3.1. Socio-Demographic Characteristics and Household Food Expenditure Patterns

Table 1 presents the socio-demographic and economic characteristics of the 624 households included in the analysis. The mean household size was 3.61 members, while the mean age of household heads was 43.70 years, indicating that the sample predominantly comprised households headed by individuals in their economically active years. Approximately half of the households were female-headed (50.3%), while 49.7% were male-headed. Regarding educational attainment, 33.97% of household heads had attained college-level education or above, whereas 18.43% had never attended formal education. Government-rented accommodation was the predominant housing arrangement, accounting for 66.03% of households.

Table 1. Socio-demographic characteristics of sample households (N = 624)

Variable / Category	Measurement	Mean / Count	Min - Max
Household size	Members (number)	3.61	2 - 7
Age of household head	Years	43.70	25 - 72
Sex of head: Male / Female	n (%)	310 (49.7%) / 314 (50.3%)	—
Education: College and above	n (%)	212 (33.97%)	—
Education: Never attended	n (%)	115 (18.43%)	—
Housing: Government rental	n (%)	412 (66.03%)	—
Wealth (PCA): Ultra-Poor	n (%)	560 (89.74%)	—
Zero to Medium Perception	n (%)	174 (27.88%)	—
High to Very High Perception	n (%)	450 (72.12%)	—

Source: Authors' survey computations (2024).

The household wealth classification revealed substantial economic vulnerability, with 89.74% of households categorized as ultra-poor according to the principal component analysis (PCA)-based wealth index. This concentration in the lowest wealth category suggests that the capacity of many sampled households to absorb food-price increases through income adjustments, savings, or asset utilization may be constrained. Such economic circumstances are particularly relevant to food-demand analysis because household expenditure decisions are influenced not only by prevailing food prices but also by the resources available to maintain consumption levels and dietary composition.

An important characteristic of the sample was the prevalence of perceived food-price pressure. Approximately 72.12% of households (n = 450) reported high-to-very-high food-price perceptions, compared with 27.88% (n = 174) reporting zero-to-medium perceptions. This distribution indicates that perceived food-price pressure was widespread among the surveyed households. The relatively large high-perception subgroup also provides an opportunity to investigate heterogeneity in food-demand responses across households experiencing different levels of perceived price pressure. Nevertheless, perception should be distinguished from objectively measured price changes, as household assessments may also reflect purchasing power, previous consumption experiences, expectations, and the frequency with which households encounter food prices.

Table 2 further illustrates the structure of household food expenditure and the distribution of zero expenditure observations across the 11 food groups. Mean monthly food expenditure was ETB 14,207.91, representing approximately 55.8% of total household expenditure. This substantial allocation to food indicates the central importance of food consumption in household budgets and suggests limited flexibility for reallocating expenditure towards non-food necessities when food prices increase.

Table 2. Budget shares, zero expenditure, and unit values across food groups (N = 624)

Food Group	Mean Share (%)	Zero Spending (%)	Unit Value (ETB)	CV (%)
Teff	30.6%	5.13%	131.90	11.6%
Wheat	16.6%	18.75%	83.21	15.8%
Rice	12.9%	3.69%	121.12	13.3%
Maize	5.9%	7.53%	64.70	18.2%
Pulses	6.0%	15.06%	144.83	14.3%
Tubers	5.0%	7.53%	61.59	21.9%
Meat	6.4%	24.04%	722.29	14.3%
Dairy Products	0.5%	34.46%	119.07	19.2%
Vegetables & Fruits	1.7%	17.79%	92.78	23.2%
Edible Oils	13.0%	2.08%	174.32	15.1%
Sweets	1.3%	11.86%	131.99	16.8%
All Cereals (Memo)	66.0%	—	—	—

Source: Authors' survey computations (2024).

The composition of food expenditure was strongly concentrated in cereal products, which collectively accounted for 66.0% of the total food budget. Teff represented the largest individual expenditure category (30.6%), followed by wheat (16.6%), rice (12.9%), and maize (5.9%). Edible oils accounted for a further 13.0% of food expenditure. Taken together, these findings demonstrate the substantial budgetary importance of staple foods and edible oils in the consumption patterns of urban households.

The predominance of cereals is consistent with the established importance of cereal-based foods in Ethiopian household consumption. Earlier evidence from the Ethiopian Household Income and Consumption Expenditure Survey similarly documented the importance of multiple staple cereals, including teff, wheat and maize, in household food consumption and expenditure patterns (Tafere et al., 2010). More recent demand-system evidence also identifies substantial heterogeneity in food demand across commodity groups and regions in Ethiopia (Vigani et al., 2019). The present findings extend this literature by documenting the concentration of food budgets among urban households experiencing considerable perceived food-price pressure.

In contrast, expenditure allocations to several food groups associated with dietary diversification were relatively small. Dairy products accounted for only 0.5% of the food budget, while vegetables and fruits represented 1.7%. Meat expenditure accounted for 6.4%. These expenditure patterns raise important concerns regarding the economic accessibility of more diversified diets, particularly in a sample in which the overwhelming majority of households were classified as ultra-poor. However, low expenditure shares should not automatically be interpreted as inadequate consumption, since expenditure data alone do not establish the quantities consumed, nutritional adequacy, or the contribution of own-produced and non-purchased foods.

The distribution of zero expenditure observations provides additional insight into household food-purchasing behaviour. Zero spending was most prevalent for dairy products (34.46%), followed by meat (24.04%), vegetables and fruits (17.79%), and wheat (18.75%). In comparison, zero expenditure was relatively uncommon for edible oils (2.08%), rice (3.69%), and teff (5.13%). These differences indicate that household participation in food-group expenditure varied substantially across commodities.

The relatively high incidence of zero expenditure for dairy and meat may reflect affordability constraints, consumption preferences, intermittent purchasing, or substitution towards alternative sources of food. Similarly, zero expenditure on vegetables and fruits may indicate barriers to dietary diversification, although the interpretation requires caution because non-purchase during the survey reference period does not necessarily imply non-consumption.

These findings have important econometric implications. In conventional demand-system estimation, excluding households with zero expenditure or treating all zero observations as continuous positive purchases can produce biased estimates when consumption is censored or infrequent. Demand systems that explicitly accommodate censored expenditure shares are therefore particularly relevant for household food-consumption data characterized by substantial non-participation across food groups. This approach is consistent with the methodological rationale for incorporating censoring into QUAIDS estimation, as discussed by Headey et al. (2023).

Overall, the expenditure structure reveals a household food economy characterized by substantial reliance on staple commodities, considerable food-budget commitments, and uneven participation across food groups. These characteristics provide an important context for interpreting the expenditure and price elasticities presented in the following sections.

3.2. Expenditure Elasticities Across Food-Price Perception Groups

Table 3 presents the estimated food-expenditure elasticities across the zero-to-medium and high-to-very-high food-price perception groups. These elasticities measure the percentage change in expenditure allocated to a particular food group associated with a 1% change in total food expenditure, holding the other relevant demand-system conditions constant. An elasticity between zero and one indicates that expenditure increases less than proportionately with total food expenditure, whereas an elasticity greater than one indicates a more-than-proportionate response.

The results reveal substantial heterogeneity in expenditure responsiveness across food categories and perception groups. Among households reporting zero-to-medium food-price perceptions, the estimated expenditure elasticities exceeded unity for rice (1.1320), maize (2.5409), tubers (1.4042), meat (1.5696), dairy products (1.4640), vegetables and fruits (1.5224), and sweets (1.9097). These estimates indicate that expenditure allocated to these categories increased more than proportionately with total food expenditure. In contrast, teff (0.7356), wheat (0.5226), pulses (0.7851), and edible oils (0.8715) exhibited expenditure elasticities below unity, suggesting comparatively less-than-proportionate expenditure responses.

Table 3. Food-budget expenditure elasticities (η) with 95% CIs across perception status

Food Group	Zero/Medium (n=174)	95% CI	High/Very High (n=450)	95% CI	Difference
Teff	W4e2	[0.660, 0.811]	0.8800	[0.833, 0.927]	+0.1444
Wheat	0.5226	[0.442, 0.603]	1.1181	[1.057, 1.179]	+0.5955
Rice	1.1320	[1.032, 1.232]	1.0038	[0.949, 1.059]	-0.1282
Maize	2.5409	[2.298, 2.784]	1.0189	[0.962, 1.076]	-1.5220
Pulses	0.7851	[0.708, 0.863]	0.9087	[0.860, 0.958]	+0.1236
Tubers	1.4042	[1.243, 1.565]	1.1990	[1.111, 1.287]	-0.2052
Meat	1.5696	[1.391, 1.748]	0.9813	[0.919, 1.044]	-0.5883
Dairy Products	1.4640	[1.297, 1.631]	0.8334	[0.777, 0.890]	-0.6306
Veg & Fruits	1.5224	[1.370, 1.675]	0.8697	[0.815, 0.925]	-0.6527
Edible Oils	0.8715	[0.789, 0.954]	1.1373	[1.073, 1.202]	+0.2658
Sweets	1.9097	[1.684, 2.135]	0.7867	[0.736, 0.838]	-1.1230

Source: Authors' survey computations (2024). QUAIDS Stata outputs (estat expenditure, atmeans).

The particularly high elasticity for maize (2.5409) suggests that maize expenditure was especially responsive to changes in total food expenditure in the zero-to-medium perception group. Similarly, the elasticities for meat, dairy products, and vegetables and fruits indicate that expenditure allocation to these food groups increased relatively rapidly as the food budget expanded. This pattern may reflect the capacity of households experiencing comparatively lower perceived food-price pressure to allocate additional resources towards food categories beyond their principal staples. Nevertheless, the estimates should be interpreted as expenditure responses rather than direct evidence of changes in dietary quality or nutritional outcomes.

A different expenditure-response pattern emerged among households reporting high-to-very-high food-price perceptions. In this group, expenditure elasticities were below unity for teff (0.8800), pulses (0.9087), meat (0.9813), dairy products (0.8334), vegetables and fruits (0.8697), and sweets (0.7867). Wheat (1.1181), rice (1.0038), maize (1.0189), tubers (1.1990), and edible oils (1.1373) exhibited point estimates above unity.

An important observation is that the expenditure responsiveness of several non-staple food groups was comparatively lower in the high-perception group. For example, the estimated elasticity for dairy products declined from 1.4640 among zero-to-medium perception households to 0.8334 among high-to-very-high perception households. A similar pattern was observed for vegetables and fruits, for which the elasticity declined from 1.5224 to 0.8697. Meat expenditure elasticity also declined from 1.5696 to 0.9813, while sweets declined from 1.9097 to 0.7867.

These differences suggest that households reporting high food-price perceptions may have a more constrained capacity to expand expenditure on several non-staple food categories as their total food budgets increase. One plausible explanation is that households facing greater perceived food-price pressure prioritize the maintenance of staple consumption and other essential food purchases, potentially limiting the expansion of expenditure on relatively

discretionary or less frequently purchased food categories. However, the cross-sectional design does not establish that price perceptions themselves caused these differences.

Conversely, wheat and edible oils exhibited higher expenditure elasticities in the high-perception group. Wheat increased from 0.5226 to 1.1181, while edible oils increased from 0.8715 to 1.1373. This finding suggests that expenditure allocation to these commodities may become relatively more responsive to increases in the food budget among households reporting greater perceived price pressure. Such responses could reflect differences in consumption priorities, substitution between food groups, or the need to maintain particular staple-based consumption patterns under constrained household budgets. The observed elasticity for wheat in the high-perception group is clearly above unity, whereas the estimates for rice and maize are statistically indistinguishable from unity because their respective confidence intervals include one.

The differences in expenditure responsiveness are particularly relevant when interpreted alongside the observed concentration of household food expenditure in cereals and edible oils. The relatively high expenditure shares of teff, wheat, rice, and edible oils indicate that these commodities occupy important positions in household food budgets. Consequently, changes in the responsiveness of expenditure towards these commodities may have substantial implications for the composition of household food consumption.

The findings can be compared with the Ethiopian QUAIDS analysis by Vigani et al. (2019), which identified cereals and animal-source products as relatively superior goods in the national food-demand system, while other crops and manufactured food products generally exhibited more necessity-oriented expenditure responses. Their study also identified regional variation in price elasticities, emphasizing the importance of contextual differences in household demand behaviour. The present study similarly demonstrates heterogeneous expenditure responses across food groups but adds an important dimension by distinguishing households according to perceived food-price pressure.

The results also contribute to the wider literature on food affordability and dietary constraints in sub-Saharan Africa. Headey et al. (2023), using nationally representative household data from Ethiopia, Kenya, Tanzania, and Uganda, demonstrated that poverty, relative food prices, and consumer preferences jointly constrain the affordability and consumption of nutritious foods. Their findings highlighted persistent consumption gaps in fruits, vegetables, pulses, and other nutritious food categories. The comparatively low expenditure shares and lower expenditure elasticities for vegetables and fruits among high-perception households in the present study are consistent with the broader concern that economic constraints can limit households' ability to expand consumption of more diverse food groups.

Nevertheless, a distinction is necessary when comparing these findings. The estimates in the present study are conditional food-budget expenditure elasticities, whereas studies using two-stage demand systems may report unconditional income elasticities that incorporate both the food-versus-non-food allocation decision and the allocation within the food budget. Differences in model specification, food-group aggregation, survey periods, and geographic coverage therefore limit direct numerical comparisons.

Importantly, the confidence intervals in Table 3 should also guide the classification of food groups. Although rice (1.0038) and maize (1.0189) have point estimates above unity in the high-

perception group, their confidence intervals include one. Their elasticities should therefore be interpreted as approximately unit elastic rather than conclusively classified as luxuries. Meat (0.9813) also has a confidence interval that includes unity. The remaining classifications are more clearly supported by the reported confidence intervals.

Taken together, these findings suggest that food-price perception is associated with distinct patterns of food-budget allocation and expenditure responsiveness. In particular, the lower expenditure elasticities for dairy, meat, vegetables and fruits, and sweets among high-perception households may indicate a narrowing of expenditure flexibility across several food categories. Such a pattern is consistent with the possibility that perceived food-price pressure reinforces the prioritization of selected staple commodities at the expense of broader food-budget diversification. However, a formal between-group test of expenditure-elasticity differences is required before concluding that these differences are statistically significant.

3.3. Marshallian Own-Price Elasticities and Heterogeneity in Price Responsiveness

Table 4 presents the estimated Marshallian (uncompensated) own-price elasticities for the 11 food groups and the corresponding tests of differences between perception groups. Marshallian elasticities capture the combined substitution and purchasing-power effects associated with a change in a commodity's own price, holding nominal total expenditure constant. Consequently, they provide an indication of how household demand responds to food-price changes under the prevailing budget constraint.

Table 4. Comparative Marshallian own-price elasticities and between-group hypothesis tests

Food Group	Zero/Medium (n=174)	High/Very High (n=450)	Difference (Δ)	z-stat (p-val)	Result (p<0.05)
Teff	-1.2780	-1.0825	+0.1955	+3.33 (p=0.0009)	Significant
Wheat	-0.8951	-0.9047	-0.0096	-0.18 (p=0.8572)	Not Significant
Rice	-1.1897	-0.9444	+0.2453	+4.22 (p<0.0001)	Significant
Maize	-1.4316	-0.9185	+0.5131	+7.13 (p<0.0001)	Significant
Pulses	-1.0272	-1.0552	-0.0280	-0.51 (p=0.6101)	Not Significant
Tubers	-1.1846	-1.0103	+0.1743	+2.65 (p=0.0080)	Significant
Meat	-1.3808	-0.9293	+0.4515	+6.27 (p<0.0001)	Significant
Dairy	-1.0016	-1.1121	-0.1105	-1.75 (p=0.0801)	Not Significant
Veg & Fruit	-0.9090	-1.0666	-0.1576	-2.88 (p=0.0040)	Significant
Edible Oils	-1.0272	-1.1838	-0.1566	-2.78 (p=0.0054)	Significant

Sweets	-0.8355	-1.0893	-0.2538	-4.63 (p<0.0001)	Significant

Source: Authors' survey computations (2024). Delta method outputs from Stata (estat uncompensated, atmeans).

The estimates reveal considerable variation in price responsiveness across food groups. Among households reporting zero-to-medium food-price perceptions, the own-price elasticities were negative for all 11 food categories. The largest absolute responses were observed for maize (-1.4316), meat (-1.3808), teff (-1.2780), rice (-1.1897), and tubers (-1.1846). These estimates indicate elastic demand, meaning that a 1% increase in the corresponding commodity price was associated with a greater than 1% reduction in its quantity demanded, under the Marshallian interpretation. In contrast, wheat (-0.8951), vegetables and fruits (-0.9090), and sweets (-0.8355) exhibited relatively inelastic demand. The own-price elasticities of pulses (-1.0272), edible oils (-1.0272), and dairy products (-1.0016) were close to unit elasticity.

Among households reporting high-to-very-high food-price perceptions, the own-price elasticities were also negative across all food groups. However, the magnitude and statistical significance of the differences varied considerably. The largest absolute elasticities were observed for teff (-1.0825), edible oils (-1.1838), pulses (-1.0552), vegetables and fruits (-1.0666), and sweets (-1.0893). The remaining commodities, including wheat (-0.9047), rice (-0.9444), maize (-0.9185), meat (-0.9293), and tubers (-1.0103), exhibited relatively smaller absolute price responses, with several estimates close to unit elasticity.

The between-group hypothesis tests provide further evidence of heterogeneous price responsiveness. Statistically significant differences were observed for eight of the eleven food groups. In particular, the own-price elasticities for teff, rice, maize, tubers, and meat became significantly less negative among households reporting high-to-very-high food-price perceptions.

The largest difference was observed for maize, for which the elasticity increased from -1.4316 to -0.9185 ($\Delta = +0.5131$; $p < 0.001$). This indicates a substantial reduction in the absolute magnitude of the estimated own-price response. Similarly, meat exhibited a change from -1.3808 to -0.9293 ($\Delta = +0.4515$; $p < 0.001$), while rice changed from -1.1897 to -0.9444 ($\Delta = +0.2453$; $p < 0.001$). Teff and tubers also exhibited statistically significant differences, with changes of +0.1955 ($p = 0.0009$) and +0.1743 ($p = 0.0080$), respectively.

These results suggest that the demand for several major food commodities was comparatively less price-elastic among households reporting high food-price perceptions. One possible interpretation is that households facing greater perceived food-price pressure have limited opportunities to reduce their consumption of certain staple commodities without compromising their basic food requirements. In this context, the comparatively smaller absolute price elasticities for teff, rice, maize, and tubers may reflect the importance of these commodities in maintaining household food consumption.

However, the interpretation requires caution. A less-negative elasticity does not necessarily imply that households are better protected from price increases or that their consumption is maintained at an adequate level. Rather, it may indicate that demand for these commodities is relatively less responsive to price changes, potentially because households have fewer

acceptable substitutes or because these commodities represent essential components of their diets. The distinction is particularly important in economically vulnerable populations, where limited substitution opportunities may coexist with substantial welfare losses.

An important contrasting pattern emerged for vegetables and fruits, edible oils, and sweets. Their own-price elasticities became significantly more negative among high-perception households. For vegetables and fruits, the elasticity declined from -0.9090 to -1.0666 (Δ = -0.1576; p = 0.0040). Edible oils changed from -1.0272 to -1.1838 (Δ = -0.1566; p = 0.0054), while sweets declined from -0.8355 to -1.0893 (Δ = -0.2538; $p < 0.001$).

These findings suggest that expenditure and consumption adjustments may differ according to the perceived importance and substitutability of individual food categories. The increased price sensitivity of vegetables and fruits may reflect their relatively small share of household food budgets and the possibility that households reduce or substitute these purchases when prices increase. Similarly, the stronger price responsiveness of sweets may reflect their relatively discretionary position in household food consumption. Edible oils, however, represent an important exception to a simple distinction between staple and discretionary foods, given their substantial budget share of 13.0%.

The absence of statistically significant differences for wheat (Δ = -0.0096; p = 0.8572), pulses (Δ = -0.0280; p = 0.6101), and dairy products (Δ = -0.1105; p = 0.0801) indicates that the evidence does not establish different own-price responses between the two perception groups for these commodities at the conventional 5% significance level. The relatively similar elasticities for wheat and pulses may reflect comparable demand responses across perception categories, although other household characteristics and substitution patterns may also contribute.

The Ethiopian evidence from Kedir (2005) provides a useful historical comparison. Using the 1994 Ethiopian Urban Household Survey, Kedir found that the estimated food commodity groups generally exhibited inelastic demand, although only a proportion of the own-price elasticities were statistically significant. The study also identified substitution and complementarity relationships across food groups. Although differences in the survey period, food aggregation, price measurement, and econometric specifications preclude direct numerical comparisons, the current findings provide more detailed evidence of heterogeneity in urban food-demand responses. In particular, the perception-stratified estimates indicate that price responsiveness is not necessarily uniform across households within the same urban food market.

The findings are also broadly consistent with the Ethiopian demand-system evidence presented by Vigani et al. (2019), which demonstrated that price elasticities vary across regions even where expenditure-elasticity patterns are relatively similar. This reinforces the importance of examining heterogeneity in food-demand responses rather than assuming that national or aggregate estimates adequately represent all household groups.

From a policy perspective, the results suggest that uniform food-price interventions may have heterogeneous effects across food categories and household groups. Commodities with relatively inelastic demand may require particular attention because households may be unable to reduce their consumption substantially in response to price increases. Conversely, the increased price sensitivity of vegetables and fruits among high-perception households raises concerns that affordability pressures may disproportionately affect food-group diversification.

Nevertheless, price elasticities alone cannot establish changes in nutrient intake or dietary adequacy; these outcomes require complementary consumption and nutrition indicators.

Overall, the Marshallian estimates demonstrate that perceived food-price pressure is associated with statistically significant differences in own-price responsiveness for eight of the eleven food groups. The contrasting directions of these differences indicate that perceived price pressure is not associated with a uniform reduction or increase in price sensitivity. Rather, the relationship varies according to the commodity concerned, highlighting the importance of food-specific demand responses in understanding urban household vulnerability.

3.4. Compensated (Hicksian) Own-Price Elasticities: Substitution Responses

Table 5 reports the compensated (Hicksian) own-price elasticities, which measure the responsiveness of demand to price changes while holding consumer utility constant. Unlike Marshallian elasticities, Hicksian elasticities isolate the substitution effect by compensating households for the purchasing-power loss associated with a price increase. Consequently, they provide a complementary perspective on food-demand adjustments and help distinguish substitution behaviour from the combined substitution and income effects captured by Marshallian elasticities.

Table 5. Compensated (Hicksian) own-price elasticities and hypothesis tests

Food Group	Zero/Medium (n=174)	High/Very High (n=450)	Difference (Δ)	z-stat (p-val)
Teff	-1.053	-0.813	+0.240	+4.28 (p<0.0001)
Wheat	-0.808	-0.719	+0.089	+1.76 (p=0.0779)
Rice	-1.044	-0.815	+0.229	+4.09 (p<0.0001)
Maize	-1.282	-0.858	+0.424	+6.32 (p<0.0001)
Pulses	-0.980	-1.001	-0.021	-0.40 (p=0.6872)
Tubers	-1.114	-0.950	+0.164	+2.67 (p=0.0076)
Meat	-1.280	-0.866	+0.414	+6.25 (p<0.0001)
Dairy	-0.994	-1.108	-0.114	-1.89 (p=0.0583)
Veg & Fruit	-0.883	-1.052	-0.169	-3.22 (p=0.0013)
Edible Oils	-0.914	-1.036	-0.122	-2.27 (p=0.0234)
Sweets	-0.811	-1.079	-0.268	-5.25 (p<0.0001)

Source: Authors' survey computations (2024). Derived via Slutsky equation with delta-method standard errors.

The estimated Hicksian own-price elasticities were negative for all eleven food groups in both perception categories. This is consistent with the theoretical expectation that compensated own-price demand responses should be non-positive under standard consumer-demand theory. Among zero-to-medium perception households, the largest absolute compensated price responses were observed for maize (-1.282), meat (-1.280), teff (-1.053), rice (-1.044), and tubers (-1.114). Wheat (-0.808), pulses (-0.980), dairy products (-0.994), vegetables and fruits (-0.883),

edible oils (-0.914), and sweets (-0.811) exhibited comparatively smaller compensated responses. In the high-to-very-high perception group, the corresponding estimates were generally less negative for several major staple commodities. Teff exhibited a compensated own-price elasticity of -0.813, compared with -1.053 in the zero-to-medium group. Rice changed from -1.044 to -0.815, while maize declined from -1.282 to -0.858. Similarly, tubers changed from -1.114 to -0.950, and meat from -1.280 to -0.866.

The between-group tests indicate that these differences were statistically significant for teff (Δ = +0.240; $p < 0.001$), rice (Δ = +0.229; $p < 0.001$), maize (Δ = +0.424; $p < 0.001$), tubers (Δ = +0.164; $p = 0.0076$), and meat (Δ = +0.414; $p < 0.001$). These results provide additional evidence that the compensated substitution responses for several major food commodities differ between households reporting lower and higher perceived food-price pressure.

The relatively smaller absolute Hicksian elasticities for staple commodities among high-perception households may indicate limited substitution possibilities, stronger consumption preferences, or a narrower range of acceptable alternatives. Such responses are particularly relevant in urban food environments where households may rely on specific cereals and staple food combinations for regular consumption. When substitution possibilities are limited, price increases can impose considerable welfare costs even if the measured compensated quantity response is relatively small.

Nevertheless, the Hicksian results also demonstrate contrasting patterns for other food groups. Vegetables and fruits exhibited a more negative compensated elasticity among high-perception households (-1.052 compared with -0.883; Δ = -0.169; $p = 0.0013$). Edible oils also became more price-responsive (-1.036 compared with -0.914; Δ = -0.122; $p = 0.0234$), while sweets exhibited a particularly notable increase in absolute price responsiveness (-1.079 compared with -0.811; Δ = -0.268; $p < 0.001$). These results indicate that the substitution response associated with price changes varies substantially across food groups. In particular, the stronger compensated price responsiveness of vegetables and fruits among high-perception households suggests that households may have greater scope or willingness to substitute away from these commodities when relative prices change. From a food-security perspective, this is noteworthy because vegetables and fruits contribute to dietary diversity and micronutrient intake. However, the estimates do not directly demonstrate that households reduce their actual nutrient consumption.

There is not statistically significant between-group differences were observed for wheat ($p = 0.0779$), pulses ($p = 0.6872$), or dairy products ($p = 0.0583$) at the 5% significance level. The wheat and dairy estimates are relatively close to the conventional threshold, but they should not be described as statistically significant at the prespecified level.

The relationship between the compensated and uncompensated estimates is particularly important for understanding the mechanisms underlying the observed food-demand responses. For example, the relatively less-negative Marshallian and Hicksian elasticities for maize, rice, teff, tubers, and meat among high-perception households suggest that the observed differences are not explained solely by the purchasing-power effect. Rather, the differences also involve variation in compensated substitution responses. This distinction has important welfare implications. A household may exhibit relatively low compensated price responsiveness because

it has limited substitution possibilities, while still experiencing a substantial reduction in real purchasing power when food prices rise. Consequently, lower absolute Hicksian elasticities should not be interpreted as evidence of lower vulnerability to food-price increases.

The broader food-demand literature similarly emphasizes the importance of distinguishing price-induced substitution from the purchasing-power effects of price changes. The Ethiopian QUAIDS study by Vigani et al. (2019) demonstrated that commodity-specific and regional differences in price responsiveness are important for assessing food-demand adjustments. The current findings extend this perspective by showing that estimated compensated price responses also vary across perception-defined household groups.

Taken together, the Marshallian and Hicksian estimates indicate that the relationship between food-price perceptions and demand responsiveness is commodity-specific. The significant differences in both elasticity measures for several staple foods suggest that the observed heterogeneity encompasses both overall purchasing responses and compensated substitution behaviour. This provides a stronger basis for interpreting household food-demand adjustments than relying exclusively on uncompensated price elasticities.

3.5. Demographic and Socioeconomic Expenditure-Scaling Parameters

Table 6 presents the estimated demographic and socioeconomic expenditure-scaling parameters (ρ) incorporated into the QUAIDS specification through the demographic scaling function:

$$m_0(z) = 1 + \rho' z$$

These parameters account for observed household characteristics that may influence the expenditure structure of food demand. Their inclusion is important because households with different demographic and socioeconomic characteristics may exhibit different consumption requirements and expenditure-allocation patterns, even when they face similar market prices and total food expenditure. The findings reveal notable differences in the statistical significance and direction of the estimated parameters across the two food-price perception groups.

Table 6. Demographic and institutional expenditure-scaling parameters (ρ)

Variable	Symbol	Zero/Medium (n=174)	z-stat (p-val)	High/Very High (n=450)	z-stat (p-val)
Household head age	Age	-0.0032***	-6.48 (p<0.001)	-0.0045	-1.44 (p=0.150)
Household size	Size	+0.0114*	+1.78 (p=0.075)	+0.1068	+1.43 (p=0.152)
Household head sex	Sex	+0.0088	+0.58 (p=0.559)	+0.0124	+1.28 (p=0.202)
House ownership	House	-0.1117***	-10.56 (p<0.001)	+0.1191	+1.43 (p=0.153)
Education level	Educ	-0.0644***	-4.99 (p<0.001)	-0.3169***	-4.56 (p<0.001)
Employment status	Emp	-0.0692***	-8.36 (p<0.001)	+0.0044	+0.90 (p=0.370)
Wealth score (PCA)	Wealth	-0.0427***	-8.68 (p<0.001)	+0.1027	+0.46

					(p=0.644)

*Source: Authors' survey computations (2024). Significance: * p < 0.10, ** p < 0.05, *** p < 0.01.*

Among households reporting zero-to-medium food-price perceptions, household-head age, housing tenure, education, employment status, and wealth score were statistically significant at the 1% level. The coefficient for household-head age was negative (-0.0032; $p < 0.001$), indicating a negative association between age and the demographic expenditure-scaling parameter. Household ownership or tenure also exhibited a negative coefficient (-0.1117; $p < 0.001$). Similarly, education (-0.0644; $p < 0.001$), employment status (-0.0692; $p < 0.001$), and household wealth (-0.0427; $p < 0.001$) were negatively associated with the scaling parameter.

Household size had a positive coefficient (+0.0114), although its statistical significance was marginal at the 10% level ($p = 0.075$). Household-head sex was not statistically significant ($p = 0.559$), suggesting that the estimated expenditure-scaling parameter did not differ significantly according to the sex variable within this subgroup, conditional on the other included characteristics.

The pattern was substantially different among households reporting high-to-very-high food-price perceptions. In this group, education was the only statistically significant demographic or socioeconomic parameter, with a negative coefficient of -0.3169 ($p < 0.001$). The coefficients for household-head age, household size, sex, housing tenure, employment status, and household wealth were not statistically significant at the 5% level.

The negative education coefficient in both groups is particularly noteworthy. Its magnitude was considerably larger among high-perception households (-0.3169) than among zero-to-medium perception households (-0.0644). This indicates that education was an important correlate of the demographic expenditure-scaling specification in both groups, although the estimated coefficient differed substantially in magnitude. One possible explanation is that education is associated with differences in household consumption preferences, food-purchasing strategies, and the allocation of limited resources. More educated household heads may have different food-budget management practices, information access, or preferences regarding the composition of household food expenditure. However, the negative coefficient should not be interpreted as direct evidence that education reduces food consumption or household welfare. Its substantive meaning depends on the variable coding, the normalization of the scaling function, and the complete specification of the demand system.

The differences in the statistical significance of the other demographic parameters are also important. In the zero-to-medium perception group, household age, housing tenure, employment, and wealth were significant, whereas these characteristics were not statistically significant in the high-perception group. This pattern may indicate that the relationship between socioeconomic characteristics and expenditure scaling differs across households with different perceived food-price experiences. However, it is important to distinguish statistical significance within individual subgroups from statistically significant differences between subgroups. The fact that a parameter is statistically significant in one group but not in another does not establish that the two coefficients are statistically different. Formal cross-equation or cross-group coefficient-equality tests would be required to substantiate such a conclusion.

These findings are broadly consistent with the wider food-demand literature, which recognizes that household demographics, socioeconomic status, and consumption preferences contribute to differences in food expenditure allocation. For example, Ali (2020), using a QUAIDS framework for rural households in southwestern Ethiopia, identified household characteristics such as age, sex, household size, education, and location as relevant correlates of food expenditure patterns. Similarly, Vigani et al. (2019) incorporated household characteristics into their Ethiopian demand-system analysis and documented differences in food-demand responses across regions.

The results also reinforce the importance of socioeconomic context in interpreting food-demand elasticities. Headey et al. (2023) demonstrated that poverty, food prices, and consumer preferences jointly shape the affordability and consumption of nutritious foods across East African countries. In the present study, the concentration of households in the ultra-poor wealth category, combined with the widespread reporting of high food-price perceptions, suggests that socioeconomic constraints may be particularly relevant to understanding the observed expenditure-allocation patterns.

Nevertheless, the demographic coefficients should be interpreted within the mathematical structure of the estimated QUAIDS model rather than as independent causal effects. The demographic scaling function modifies the expenditure component of the demand system; its parameters do not necessarily represent direct changes in the quantity demanded of individual food groups. Moreover, the interpretation of categorical variables depends on their coding and reference categories, which should be clearly documented in the Methods section.

Overall, the demographic results suggest that household characteristics are associated with expenditure scaling differently across the two perception-defined groups. Education emerges as the most consistent statistically significant correlate, whereas the importance of age, housing tenure, employment, and wealth is concentrated in the zero-to-medium perception group. These findings highlight the relevance of household heterogeneity in food-demand analysis, while also indicating the need for formal cross-group coefficient tests before concluding that the underlying demographic relationships differ statistically.

3.6. Integrated Interpretation: Food-Price Perceptions, Household Demand Heterogeneity, and Food-Budget Vulnerability

Taken together, the findings demonstrate that household food-demand responses in urban Ethiopia are heterogeneous across food commodities and food-price perception categories. The differences extend beyond the overall allocation of food expenditure to include the responsiveness of expenditure to changes in the food budget and the sensitivity of demand to own-price changes.

Three interconnected findings emerge from the analysis.

First, household food expenditure is highly concentrated in staple commodities. Cereals account for approximately two-thirds of the food budget, while expenditure allocations to dairy products, vegetables, and fruits remain relatively small. This pattern is particularly important given that 89.74% of households were classified as ultra-poor and that more than half of total household expenditure was allocated to food. The combination of high food-budget commitments and limited economic resources suggests that many households have restricted flexibility to absorb

food-price increases without adjusting their consumption patterns.

Second, households reporting high-to-very-high food-price perceptions exhibit a different pattern of expenditure responsiveness from those reporting zero-to-medium perceptions. The lower expenditure elasticities observed for meat, dairy, vegetables and fruits, and sweets suggest comparatively limited expenditure expansion in these categories as the food budget increases. Conversely, higher elasticities for wheat and edible oils suggest that certain staple-related commodities may receive greater expenditure priority within constrained food budgets. These findings indicate that perceived food-price pressure is associated with differences in the composition of household food expenditure rather than a uniform adjustment across all food groups.

Third, the own-price elasticity estimates reveal that perceived food-price pressure is associated with different patterns of price responsiveness. The less-negative own-price elasticities for teff, rice, maize, tubers, and meat suggest relatively weaker quantity responses to price changes among high-perception households. In contrast, the greater price sensitivity of vegetables and fruits, edible oils, and sweets suggest that households may adjust their consumption of these commodities more readily when their prices increase. The corresponding Hicksian estimates demonstrate that these differences are also present in compensated substitution responses, indicating that the observed heterogeneity is not attributable exclusively to changes in purchasing power.

An important implication is that relatively low-price responsiveness should not automatically be interpreted as resilience. Households may exhibit limited substitution away from essential staple foods precisely because their consumption options are constrained. Under these circumstances, price increases can reduce real purchasing power and household welfare even when the quantity demanded changes relatively little. Conversely, stronger price responsiveness for vegetables and fruits may indicate that households have to make difficult adjustments to food diversity when faced with relative price increases.

The demographic expenditure-scaling results provide further evidence that household characteristics are relevant to understanding these demand patterns. Education was statistically significant in both perception groups, whereas age, housing tenure, employment, and wealth were significant only in the zero-to-medium perception group. Although these findings require formal cross-group testing before differences can be established statistically, they suggest that household socioeconomic characteristics should be considered when interpreting aggregate food-demand responses.

The overall findings are consistent with the broader Ethiopian and sub-Saharan African literature demonstrating that household food demand is shaped by the interaction of prices, expenditure constraints, socioeconomic characteristics, and consumer preferences (Headey et al., 2023; Vigani et al., 2019). However, the contribution of the present analysis is its examination of expenditure and price elasticities across household groups differentiated by perceived food-price pressure.

This perspective has particular relevance for urban food-security policy. Food-price monitoring and policy responses should consider not only the magnitude of price increases but also the different ways in which households adjust their food budgets and consumption choices.

Interventions that improve the affordability of nutritious foods, stabilize access to essential staples, and strengthen the purchasing power of economically vulnerable households may help reduce the pressure to prioritize a narrow range of food commodities.

Importantly, the findings do not establish that food-price perceptions independently cause changes in food demand. The cross-sectional design cannot distinguish the causal influence of perceptions from the influence of underlying household economic conditions, previous consumption experiences, and unobserved preferences. Nevertheless, the observed differences provide useful empirical evidence that perception-defined household groups may exhibit distinct food-demand patterns and warrant further investigation using longitudinal or repeated cross-sectional data.

4. Conclusion and Policy Recommendations

4.1. Conclusion

This study examined how perceived food-price shock pressure is associated with household food-demand behaviour in urban Ethiopia, with particular emphasis on differences in expenditure and price elasticities across households reporting different levels of perceived food-price pressure. Using household survey data from 624 households and a Quadratic Almost Ideal Demand System (QUAIDS) framework, the analysis provides evidence of substantial heterogeneity in food-demand responses across food commodities and perception-defined household groups. By integrating household perceptions into food-demand analysis, the study extends conventional demand-system approaches beyond aggregate price and expenditure responses to examine how perceived economic pressure relates to the allocation of household food budgets and commodity-specific consumption adjustments.

The findings reveal that household food expenditure is characterized by a high degree of budgetary concentration and economic vulnerability. Food expenditure accounted for approximately 55.8% of total household expenditure, while cereals represented 66.0% of the food budget. Teff, wheat, and rice constituted particularly important components of household food expenditure. Furthermore, the high proportion of households classified as ultra-poor (89.74%) and the substantial prevalence of high-to-very-high food-price perceptions (72.12%) indicate that many sampled households operated under considerable economic constraints. The limited expenditure allocation to dairy products and vegetables and fruits, combined with the relatively high incidence of zero expenditure for several food groups, further highlights the uneven distribution of household food budgets and potential barriers to dietary diversification.

A central finding is that expenditure elasticities differed considerably between households reporting lower and higher perceived food-price pressure. Among households reporting zero-to-medium perceptions, meat, dairy products, vegetables and fruits, and sweets exhibited expenditure elasticities substantially above unity. In contrast, the corresponding elasticities among high-to-very-high perception households were below unity. This pattern suggests that expenditure allocated to several non-staple food categories was less responsive to increases in total food expenditure among households reporting greater perceived price pressure. Conversely, wheat and edible oils exhibited higher expenditure elasticities in the high-perception group, suggesting that the allocation of additional food expenditure towards selected staple-related commodities may become relatively more responsive under perceived economic

pressure. These findings indicate that perceived food-price pressure is associated with differences in the composition and responsiveness of household food expenditure rather than uniform adjustments across all food groups.

The analysis of Marshallian own-price elasticities further demonstrates that the relationship between perceived food-price pressure and household demand responsiveness is commodity-specific. Significantly less-negative own-price elasticities were observed for teff, rice, maize, tubers, and meat among households reporting high-to-very-high perceptions. This suggests comparatively lower price responsiveness for these commodities, potentially reflecting their importance in household food consumption and limited opportunities for substitution. In contrast, vegetables and fruits, edible oils, and sweets exhibited significantly more-negative own-price elasticities, indicating greater price responsiveness among the high-perception group. These contrasting responses suggest that households may prioritize certain essential food commodities while adjusting their consumption of other food groups more readily when confronted with price increases.

The compensated Hicksian estimates reinforce this interpretation by demonstrating that significant differences in price responsiveness also persist after accounting for the purchasing-power effect of price changes. The less-negative compensated own-price elasticities for teff, rice, maize, tubers, and meat among high-perception households indicate differences in substitution responses for these commodities. Conversely, the greater compensated price sensitivity observed for vegetables and fruits, edible oils, and sweets suggests that substitution behaviour also varies across food groups. Importantly, relatively low price responsiveness should not be interpreted as evidence of reduced vulnerability. Rather, it may reflect limited substitution opportunities, stronger consumption preferences, or the essential role of particular commodities in household diets. Consequently, households may continue purchasing essential foods despite price increases while experiencing substantial reductions in real purchasing power and overall welfare.

The demographic expenditure-scaling results provide additional evidence that household characteristics are relevant to understanding food-demand heterogeneity. Education was statistically significant in both perception groups, whereas household-head age, housing tenure, employment status, and wealth were statistically significant only among households reporting zero-to-medium food-price perceptions. These findings suggest that the relationship between household characteristics and expenditure scaling may vary across perception-defined groups, although formal cross-group coefficient tests are necessary before concluding that the estimated parameters differ statistically.

Overall, the findings support the importance of incorporating household food-price perceptions into empirical food-demand analysis. While conventional demand-system estimates provide valuable information on aggregate responses to changes in prices and expenditure, they may conceal important differences among households experiencing varying degrees of perceived economic pressure. The present analysis demonstrates that such heterogeneity is particularly relevant for understanding the expenditure and price responsiveness of staple commodities and food groups important for dietary diversification.

The study therefore contributes to the literature by providing perception-stratified evidence on

urban household food-demand elasticities in Ethiopia. Its findings suggest that food-price perceptions offer a potentially important analytical dimension for understanding how households allocate limited food budgets and adjust commodity-specific demand under economic pressure. However, given the cross-sectional design, the observed differences should be interpreted as associations rather than causal effects of food-price perceptions on household demand behaviour.

4.2. Policy Recommendations

The findings have several implications for food-security policy, urban social protection, food-price stabilization, and nutrition-sensitive interventions in Ethiopia. In particular, the observed heterogeneity in household food-demand responses suggests that policy interventions should move beyond uniform approaches to food-price shocks and consider differences in household economic vulnerability, commodity-specific demand responsiveness, and perceived food-price pressure. The following recommendations emerge from the empirical findings.

1) Strengthen Targeted Social Protection and Urban Food Affordability Interventions

The high proportion of households classified as ultra-poor (89.74%), together with the substantial share of household expenditure allocated to food (55.8%), underscores the importance of strengthening urban social protection mechanisms. Households with limited economic resources and high perceived food-price pressure may have restricted capacity to absorb increases in food prices without compromising other essential expenditures or adjusting their food consumption patterns.

Urban social protection programmes should therefore prioritize economically vulnerable households through appropriately targeted cash transfers, food vouchers, and other purchasing-power support mechanisms. Where feasible, transfer values should be periodically reviewed against changes in the cost of essential food baskets to preserve their real purchasing power. Targeting approaches should consider household poverty, food expenditure burdens, household composition, and indicators of perceived food-price pressure rather than relying exclusively on income or administrative poverty classifications. Particular attention should be given to households whose food expenditure commitments are high relative to their available resources. Such interventions could help protect household purchasing power and reduce the need for adverse food-budget adjustments during periods of food-price instability.

2) Prioritize the Affordability and Accessibility of Nutrient-Dense Foods

The relatively low expenditure shares allocated to dairy products (0.5%) and vegetables and fruits (1.7%), alongside the lower expenditure elasticities for these food groups among high-perception households, highlight the importance of addressing the affordability of diverse and nutritious foods. The findings suggest that households reporting greater perceived food-price pressure may have less capacity to expand expenditure on these categories as their food budgets increase.

Nutrition-sensitive food policies should therefore prioritize improving the affordability, availability, and accessibility of nutrient-dense foods in urban markets. Potential interventions include strengthening urban and peri-urban horticultural value chains, improving storage and transportation infrastructure, reducing post-harvest losses, supporting local dairy production and distribution systems, and improving market linkages between smallholder producers and urban

consumers.

Where appropriate, targeted food vouchers or nutrition-sensitive purchasing subsidies could be considered to improve access to selected nutritious food groups among economically vulnerable households. These measures should complement broader purchasing-power interventions rather than operate as isolated nutrition programmes. The policy priority should be to improve households' economic access to diverse foods, particularly vegetables, fruits, dairy products, pulses, and other nutrient-rich commodities, while recognizing that expenditure shares alone do not establish actual dietary intake or nutritional adequacy.

3) Develop Commodity-Specific Food-Price Monitoring and Response Mechanisms

The contrasting Marshallian and Hicksian own-price elasticities demonstrate that household demand responses differ considerably across food commodities. The relatively less-negative own-price elasticities for teff, rice, maize, tubers, and meat among high-perception households suggest comparatively limited demand adjustment in response to price changes. Conversely, the greater price sensitivity observed for vegetables and fruits, edible oils, and sweets indicates that households may adjust their consumption of these commodities more readily when prices increase.

These findings support the development of more disaggregated food-price monitoring and policy-response systems. Rather than relying exclusively on aggregate food inflation indicators, relevant government institutions should monitor price movements and affordability across individual food groups, particularly commodities with substantial budget shares and those important for dietary diversity.

Such monitoring could be integrated into existing urban market information systems and food-security surveillance mechanisms to identify commodities experiencing substantial price increases and households reporting heightened affordability constraints. Regular monitoring of food-price perceptions could complement conventional consumer price indices by providing information on how households experience and interpret changing market conditions.

Importantly, household perceptions should complement rather than replace objective price monitoring. Combining market-price data with household-reported experiences could provide a more comprehensive understanding of the relationship between food-price developments and household purchasing behaviour.

4) Protect Access to Essential Staple Foods While Strengthening Market Resilience

The concentration of household food expenditure in cereals (66.0%) demonstrates the importance of staple food markets for urban food security. The observed relatively low-price responsiveness of teff, rice, and maize among high-perception households suggests that demand for these commodities may be comparatively difficult to adjust when their prices increase.

Policy measures should therefore strengthen the resilience and efficiency of staple-food supply chains, including production, aggregation, storage, transportation, wholesale distribution, and retail market systems. Particular attention should be directed towards reducing avoidable supply-chain costs, improving market information, strengthening competition, and addressing logistical bottlenecks that contribute to food-price instability.

Interventions should also support more reliable market linkages between rural production areas and urban consumption centres. In the Ethiopian context, improving the efficiency of domestic cereal supply chains and reducing post-harvest losses could contribute to more stable food availability and improved market access. However, staple-food affordability interventions should not be pursued at the expense of dietary diversification. Policies that stabilize cereal markets should be complemented by measures that improve access to nutritious non-staple foods, thereby avoiding an overly narrow focus on caloric availability alone.

5) Integrate Household Perceptions into Urban Food-Security Surveillance and Early-Warning Systems

One of the central contributions of this study is the demonstration that households reporting different levels of perceived food-price pressure exhibit different estimated food-demand responses. This suggests that conventional food-security monitoring systems based primarily on market prices, inflation rates, and aggregate expenditure indicators may not fully capture household experiences of food-price pressure.

Relevant government institutions, including the Ethiopian Statistics Service, the Ministry of Agriculture, the Ministry of Trade and Regional Integration, and urban administrations, should consider incorporating standardized household food-price perception indicators into existing food-security and market surveillance systems.

Such indicators could capture perceived changes in food affordability, the frequency of food-budget adjustments, difficulties maintaining usual food purchases, and household responses to increases in the prices of essential commodities. When combined with objective market-price information, these indicators could help identify emerging affordability pressures and inform timely policy responses.

Particular attention should be given to households reporting persistently high food-price pressure, especially where such perceptions coincide with high food expenditure burdens, low economic resources, and reduced expenditure responsiveness for nutrient-dense food categories. Nevertheless, perception indicators should be interpreted alongside objective economic and consumption measures, since perceptions can also reflect expectations, purchasing experiences, and household-specific circumstances.

6) Promote Nutrition-Sensitive Economic and Livelihood Interventions

The observed concentration of food expenditure in cereals and the limited allocation to several nutrient-dense food groups suggest that food affordability is an important consideration in promoting healthier and more diversified diets. While the study does not directly measure dietary adequacy, its findings indicate that household expenditure constraints may limit the capacity to diversify food purchases.

Urban livelihood and economic empowerment interventions should therefore be integrated with nutrition-sensitive food-security programming. Such interventions could include support for sustainable income-generating activities, employment opportunities, vocational skills development, women's economic participation, and small-scale urban and peri-urban food production.

In particular, interventions targeting economically vulnerable households should recognize that

improvements in household resources do not necessarily translate uniformly into more diverse food consumption. Complementary nutrition education, consumer information, and improved access to affordable nutritious foods may help households translate increased purchasing power into healthier food choices. The significant association between education and the demographic expenditure-scaling parameter in both perception groups also suggests the importance of understanding the relationship between household characteristics and food-budget allocation. However, nutrition education should complement, rather than substitute for, interventions addressing structural affordability and market-access constraints.

7) Strengthen Evidence-Based and Distributionally Sensitive Food-Price Policies

Finally, the findings underscore the importance of incorporating household heterogeneity into the design and evaluation of food-price and food-security policies. The differences in expenditure and price elasticities indicate that aggregate estimates may conceal important variations in household responses across food categories and perception groups. Policy assessments should therefore examine not only the average effects of food-price changes but also their potential distributional implications for households with different economic circumstances and perceived levels of food-price pressure.

In particular, the combination of household food-budget concentration, limited expenditure responsiveness for several nutrient-dense foods, and commodity-specific price sensitivity highlights the need for coordinated interventions linking social protection, food-market development, nutrition, and urban economic policy. A more integrated policy framework would recognize that improving urban food security requires more than stabilizing food availability. It also requires ensuring that households possess sufficient and sustainable purchasing power to access a diverse, affordable, and nutritious diet.

5. Study Limitations and Directions for Future Research

Several limitations should be considered when interpreting the findings of this study.

First, the cross-sectional nature of the household survey limits the ability to establish causal relationships between perceived food-price pressure and household food-demand responses. Although the analysis identifies differences in estimated expenditure and price elasticities across perception-defined groups, these differences may also reflect underlying socioeconomic characteristics, household preferences, market access, and previous consumption experiences. Accordingly, the findings should be interpreted as associations rather than causal effects of food-price perceptions on household demand behaviour. Future research using longitudinal household data or repeated cross-sectional surveys could examine how changes in perceived food-price pressure relate to adjustments in food expenditure and consumption over time.

Second, the classification of households according to perceived food-price pressure relies on self-reported assessments. Although household perceptions provide important information about experienced affordability constraints, they may not correspond directly to objectively measured changes in food prices. Perceptions may also be influenced by household income, expectations, purchasing frequency, and previous exposure to price changes. Future studies should therefore integrate household perception indicators with longitudinal market-price information, food consumer price indices, and commodity-specific price changes to distinguish perceived price

pressure from objectively observed food-price movements.

Third, the analysis is based on urban households in the study area and should not automatically be generalized to rural households or other urban settings in Ethiopia. Food consumption patterns, market access, income sources, food preferences, and exposure to price fluctuations may differ considerably across geographic contexts. Further research covering multiple Ethiopian cities, secondary urban centres, and rural areas would help establish whether the observed perception-related demand heterogeneity is consistent across different food-market environments.

Fourth, the use of household expenditure and unit-value information introduces potential measurement limitations. Household-specific unit values may reflect differences in product quality, purchasing locations, transaction characteristics, and measurement practices in addition to market-price variation. Although the demand-system framework provides a structured approach to estimating household demand responses, future studies could strengthen price measurement by integrating household expenditure records with independently collected market-price data.

Fifth, although the study incorporates demographic and socioeconomic characteristics into the QUAIDS specification, unobserved household preferences and other contextual factors may still influence the estimated demand relationships. In addition, the differences in household characteristics and sample sizes between the two perception groups may affect the comparability and precision of subgroup estimates. Future research should consider pooled demand-system specifications with explicit interaction terms, formal tests of cross-group parameter equality, and alternative perception classifications to examine the robustness of the observed differences.

Finally, the analysis focuses primarily on food expenditure and demand elasticities rather than directly measuring dietary quality, nutrient intake, or nutritional outcomes. Consequently, the relatively low expenditure shares and expenditure responsiveness of certain food groups should not be interpreted as definitive evidence of inadequate dietary intake or nutritional deprivation. Future research could integrate QUAIDS estimation with individual dietary diversity indicators, household dietary diversity scores, nutrient consumption estimates, food security measures, and child nutritional outcomes. Such integrated approaches would provide a more comprehensive understanding of how perceived food-price pressure relates to household purchasing decisions, dietary adjustments, and nutritional resilience.

Despite these limitations, the study provides useful empirical evidence on the importance of household perceptions in understanding urban food-demand heterogeneity. It offers a foundation for further research examining the interaction between perceived food-price pressure, household economic vulnerability, food affordability, and nutritional outcomes in Ethiopia and comparable low- and middle-income countries.

Abbreviations

AIDS, Almost Ideal Demand System; CPI, consumer price index; CSA, Central Statistical Agency; CV, coefficient of variation; EA, enumeration area; ETB, Ethiopian Birr; FAO, Food and Agriculture Organization; NSD, negative semi-definite; PCA, principal component analysis; QUAIDS, Quadratic Almost Ideal Demand System; SD, standard deviation; SE, standard error; SUR, seemingly unrelated regression;

UPSNP, Urban Productive Safety Net Project.

Declarations

Ethical approval. Ethical clearance for this study was granted by the Addis Ababa University Institutional Review Board (Ref: 084/08/2024). All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the principles of the Declaration of Helsinki.

Consent to participate. Before data collection, the study objectives, procedures, potential risks and voluntary nature of participation were explained to all participants. Written informed consent was obtained from each participant before enrolment. Participants were informed that they could withdraw at any time without consequence.

Consent to publish. Not applicable. The manuscript does not contain identifiable individual-level data, images or personal details requiring consent for publication.

Competing interests. The authors declare that they have no competing interests.

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Availability of data and materials. The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Clinical trial registration. Not applicable.

Author approval and submission statement. The authors confirm that the work has not been published previously, is not under consideration for publication elsewhere, and has been approved for submission by all authors and the responsible institutional authorities.

Authors' contributions. Solomon Girma Yirdaw contributed to conceptualization, study design, data collection, data curation, formal analysis, methodology, investigation, visualization, manuscript writing, review, editing and validation. Messay Mulugeta Tefera, Mogessie Ashenafi and Solomon Tsehay Feleke each contributed to study design, methodology, analysis, manuscript review, supervision and validation. All authors read and approved the final manuscript.

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