Estimating censored food demand in Mexico with `quaidsce`

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Introduction

- In Mexico, 37% of household expenditure is devoted to **food purchase** (INEGI, 2022).
- 24% of households face moderate or severe **food insecurity** (CONEVAL, 2022).
- Accurately estimating **food price elasticities** is critical for the design of effective food security policies.
- The **National Household Expenditure Survey (ENIGH)** provides valuable insights into the heterogeneity of consumer preferences.

Introduction

- **High Incidence of Zero Consumption**

In household expenditure surveys, it is common to find a high proportion of households reporting zero consumption for certain products.

w_cereal	w_meat	w_dairy	w_fruit	w_fish
.215095	.0905668	.0396217	.2867938	0
.0446635	.7940464	.1116627	0	0
.0806077	.3041832	0	0	0
.3073747	.307381	.2254088	0	0
.0421782	.3339207	0	0	.2460472
.6486515	0	.3513485	0	0

Note: Budget Share (w_i)

Source: Data ENIGH 2022.

How to deal with zero shares?

- Amemiya, T. (1974)
- Deaton (1984)
- Heien and Wessells (1990)
- Shonkwiler and Yen (1999)
- Yen and Lin (2006)
- Meyerhoefer et al.(2005)
- Tauchmann (2010)

- Caro et al. (2021) have developed the Stata command **`quaidsce`**, which provides an implementation of Shonkwiler and Yen's estimator.

Introduction

Hypothesis

- Failing to account for zero consumption introduces **bias** in the demand elasticity estimates across different food groups.

Objectives

- Model the demand for the main **14 food groups** consumed in Mexico.
- Estimate the parameters of household **demographic characteristics.**
- Calculate **expenditure and own-price elasticities** for each food group.

Data: Survey Description (ENIGH 2022)

Table 1. Household characteristics

Characteristics	% of HHs	Mean
Male HH head	65.2	--
Age of the HH head	--	51 (15.4)
HH head with basic education	58.5	--
HH head with high school education	21.0	--
HH head with undergraduate education	17.4	--
HH head with graduate education	3.3	--
Total HH members	--	3.3 (1.7)

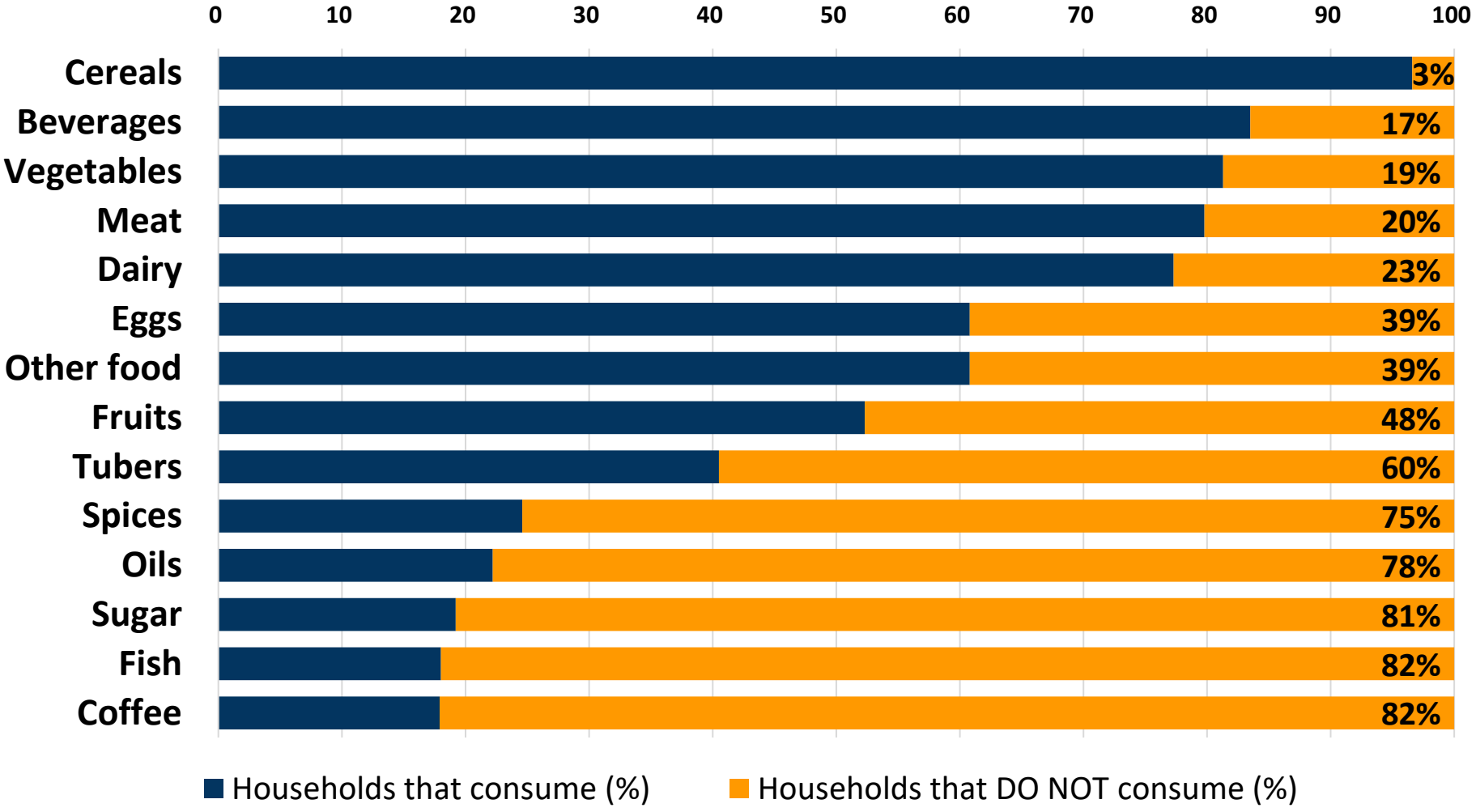
Note: Household (HH)

Figure 1. Region of residence

Source: ENIGH 2022.

Data

Figure 2. Percentage of households with zero consumption



Source: ENIGH 2022.

Data: Sample

- All households that **did not report food expenditure** within the household were excluded from the sample.
- Only households located in communities with more than **15,000 inhabitants** were selected (urban population).
- A random 10% **subsample** (4,199 households) was used, maintaining the stratified sampling design.

Methodology: QUAIDS

$$w_{ih} = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} p_{jh} + \beta_i \ln\left[\frac{m_h}{a(p)}\right] + \frac{\lambda_i}{b(p)} \left\{\ln\left[\frac{m_h}{a(p)}\right]\right\}^2 + \sum_{k=1}^{K} \eta_{ik} z_{kh} + u_{ih} \qquad \textbf{(1)}$$

where w_{ih} is the expenditure share in the good i of the household h, p_{jh} is the price of the good j for the household h, m_h is the total expenditure of the household h, z_{kh} is the demographic characteristic of the household h, and u_{ih} is the error term. And the price deflactors: $a(p)$ and $b(p)$

$$\ln a(p) = \alpha_0 + \sum_{j=1}^{N} \alpha_i \ln p_{jh} + \sum_{j=1}^{N}\sum_{k=1}^{K} \eta_{ik} z_{kh} \ln p_{jh} + \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} \gamma_{ij} \ln p_{jh}\,; \qquad b(p) = \prod_{j=1}^{N} p_{jh}^{\beta_i} \qquad \textbf{(2 \& 3)}$$

The model imposes the standard restrictions of additivity, homogeneity, and symmetry.

Methodology: Shonkwiler and Yen's Two-Step Estimator

1st Step: Estimate probability of positive consumption using a probit model

$$d_{ih}^{*} = \mathbf{z}_{ih}^{\mathrm{T}}\boldsymbol{\alpha}_i + v_{ih} \quad \longrightarrow \quad \mathrm{d}_{ih} = \begin{cases} 1 \;\; if \;\; d_{ih}^{*} > 0 \\ 0 \;\; otherwise \end{cases} \qquad \textbf{(4)}$$

2nd Step: Estimate corrected demand system

$$w_{ih}^{*} = f(\mathbf{x}_{ih}, \boldsymbol{\theta}_i) + e_{ih} \quad \longrightarrow \quad w_{ih} = d_{ih} w_{ih}^{*}$$

$$w_{ih} = \Phi\left(\boldsymbol{z}_{ih}^{\mathrm{T}}\widehat{\boldsymbol{\alpha}}_i\right) f(\mathbf{x}_{ih}, \boldsymbol{\theta}_i) + \delta_{\mathrm{i}}\phi\left(\boldsymbol{z}_{ih}^{\mathrm{T}}\widehat{\boldsymbol{\alpha}}_i\right) + \eta_{ih} \qquad \textbf{(5)}$$

- $\widehat{\boldsymbol{\alpha}}_i$ is the maximum likelihood probit estimator of $\boldsymbol{\alpha}_i$
- $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal PDF and CDF
- Error terms e_{ih} and v_{ih} are bivariate normal distribution with $cov(e_{ih}, v_{ih}) = \delta_{\mathrm{i}}$
- δ_{i} is the correction factor, η_{ih} is the error term
- Estimate the system of equation via **SUR**

Methodology: Stata commands

quaids vs **quaidsce**

```
demandsys quaids varlist_expshares,
prices(varlist_prices)
expenditure(varlist_exp)
demographics(varlist_demo)
piconstant(#)

estat elasticities, exp atmeans
estat elasticities, comp atmeans
estat elasticities, uncomp atmeans
```

```
quaidsce varlist_expshares,
prices(varlist_prices)
expenditure(varlist_exp)
demographics(varlist_demo)
anot(#)

estat expenditure, atmeans
estat compensated, atmeans
estat uncompensated, atmeans
```

Results

Table 2. Demographic parameters of the uncensored demand system (**`demandsys quaids`**)

	Region				Head of household					Household
	NW	NE	C	SE	sex	age	basic	high	graduate	members
Cereals	**-0.0164**	**-0.0154**	**-0.0055**	**-0.0052**	**0.0072**	**0.0001**	**0.0514**	**0.0389**	**0.0353**	**0.0016**
Meats	0.0074	0.0066	**0.0121**	**0.0218**	**-0.006**	0.0001	-0.0045	-0.0007	-0.0039	**0.0061**
Fish	**0.008**	-0.0008	-0.0001	0.0012	**-0.0024**	**0.0001**	**-0.0091**	**-0.0075**	-0.0049	0.0001
Dairy	-0.0005	**-0.0056**	-0.0005	**-0.0104**	**0.0075**	0	-0.0014	-0.0011	0.0035	-0.0002
Eggs	**0.0033**	-0.0009	**-0.0038**	**-0.0028**	**0.004**	0	**0.016**	**0.0125**	**0.011**	-0.0001
Oils	**0.0021**	**0.0032**	0.0005	-0.0001	-0.0007	0	-0.0016	-0.0019	**-0.0038**	**0.0004**
Tubers	-0.0001	-0.0005	-0.0005	**-0.0022**	**0.0015**	0	0.0013	0.0019	0.0008	0.0002
Vegetables	-0.0014	-0.0005	0.0021	**-0.0057**	-0.0004	**0.0003**	0.0038	0.0014	-0.0031	0.0003
Fruits	0.0013	-0.0022	0.0018	**-0.0032**	-0.0003	**0.0002**	**-0.0224**	**-0.0183**	**-0.0144**	**-0.0008**
Sugar	-0.0006	**-0.0017**	0	0.0001	-0.0002	0	0	-0.0005	-0.0012	-0.0001
Coffee	**0.0019**	-0.0009	0.0009	0.0012	**-0.0011**	0	0.0002	-0.0003	0.0003	**-0.0003**
Spices	**0.0013**	**0.0021**	-0.0001	-0.0004	0	0	0.0004	0.0004	0	**0.0002**
Other food	**-0.0099**	0.004	**-0.0079**	0.0049	**-0.0067**	**-0.0007**	**-0.0489**	**-0.0372**	**-0.0345**	**-0.004**
Beverages	0.0035	**0.0125**	0.0008	0.0008	-0.0023	**-0.0003**	**0.0149**	**0.0124**	**0.0147**	**-0.0034**

Source: Author's calculations based on data from ENIGH 2022

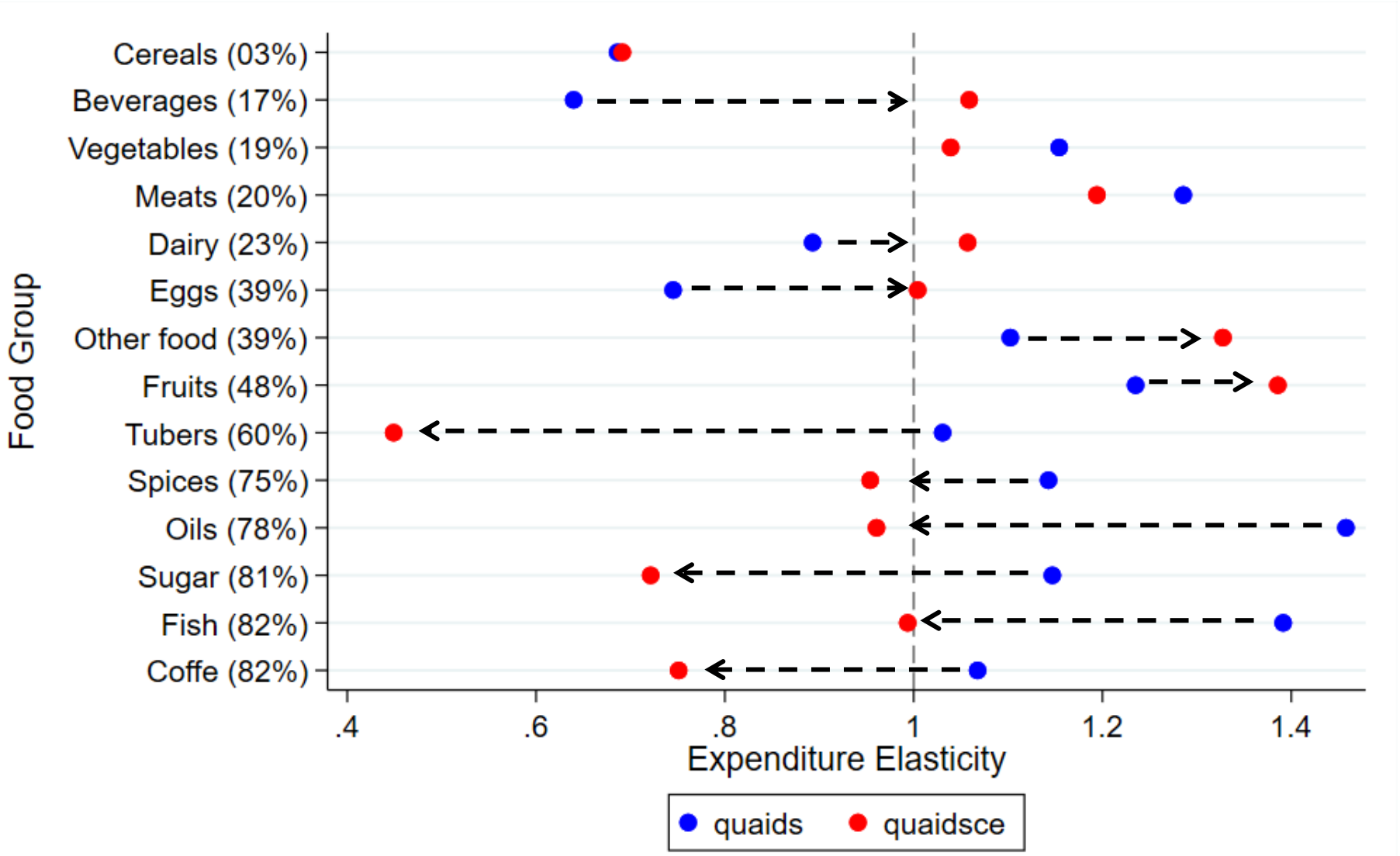
Results

Table 3. Demographic parameters of the censored demand system (**`quaidsce`**)

	Region				Head of household					Household
	NW	NE	C	SE	sex	age	basic	high	graduate	members
Cereals	0.0021	0.0007	-0.0001	-0.0019	**0.0043**	0	**0.0093**	0.0077	**0.0089**	0.0001
Meats	0.0006	0.0013	0	-0.0015	**-0.0029**	0	-0.0083	-0.0073	-0.0075	-0.0005
Fish	0.0006	0.0005	0.0004	-0.0001	-0.0004	0	0.0024	0.0017	0.0012	-0.0001
Dairy	-0.0007	0	-0.0008	0.0014	-0.0001	0	-0.0027	-0.0019	-0.0019	**-0.0004**
Eggs	-0.001	-0.001	0.0017	0.0008	0.0002	0	-0.0003	-0.0001	0.0002	0.0003
Oils	-0.0003	-0.0008	0.0001	0.0003	0.0005	0	0.0001	-0.0002	0.0001	0.0003
Tubers	0.0001	0.0003	0.0004	0.0012	0.0008	0	0.0021	0.0018	0.0014	0.0001
Vegetables	-0.0006	0.0006	-0.0003	0.0013	-0.0006	0	-0.0023	-0.0013	-0.0005	-0.0001
Fruits	-0.0004	-0.0006	0	-0.0004	**-0.0011**	0	0.0037	0.0032	0.0022	0.0002
Sugar	0.0002	**0.001**	-0.0003	-0.0004	**0.0005**	0	0.0007	0.0009	0.0011	0.0001
Coffee	-0.0004	-0.0003	-0.0005	-0.0006	0.0001	0	-0.0013	-0.0009	-0.0007	-0.0001
Spices	0.0003	-0.0004	0.0001	0.0002	-0.0001	0	0	-0.0003	-0.0008	0.0001
Other food	**0.0019**	0.0006	0.0008	0	**-0.0015**	0	0.001	0.0002	0.0002	0
Beverages	**-0.0025**	-0.002	-0.0013	-0.0002	0.0004	**0.0001**	-0.0043	-0.0037	-0.0039	0

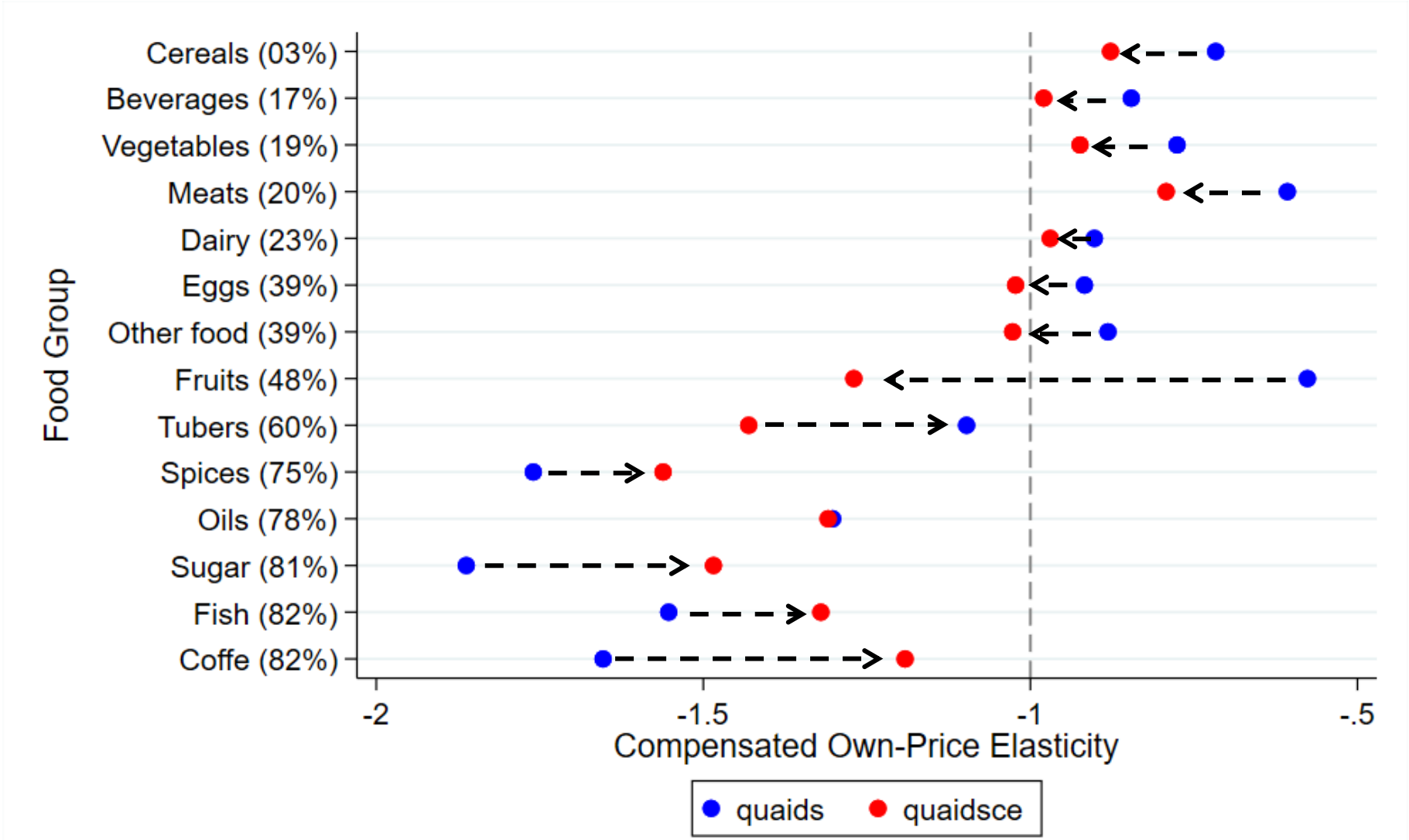
Source: Author's calculations based on data from ENIGH 2022

Figure 3. Expenditure Elasticity (**`quaids`** vs **`quaidsce`**)



Source: Author's calculations based on data from ENIGH 2022

Figure 4. Compensate Own-Price Elasticity (**`quaids`** vs **`quaidsce`**)



Source: Author's calculations based on data from ENIGH 2022

Conclusions

- Incorporating censoring significantly **enhances the robustness**, equity, and policy relevance of food demand analysis.
- Ignoring zero consumption leads to **biased elasticity estimates**, especially for products with high proportions of zero purchases.
- The results have direct implications for the design and evaluation of price-based **food policies**, such as taxes and subsidies.
- Increasing the **sample size** is recommended to improve the precision of demographic parameter estimates.

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Q & A

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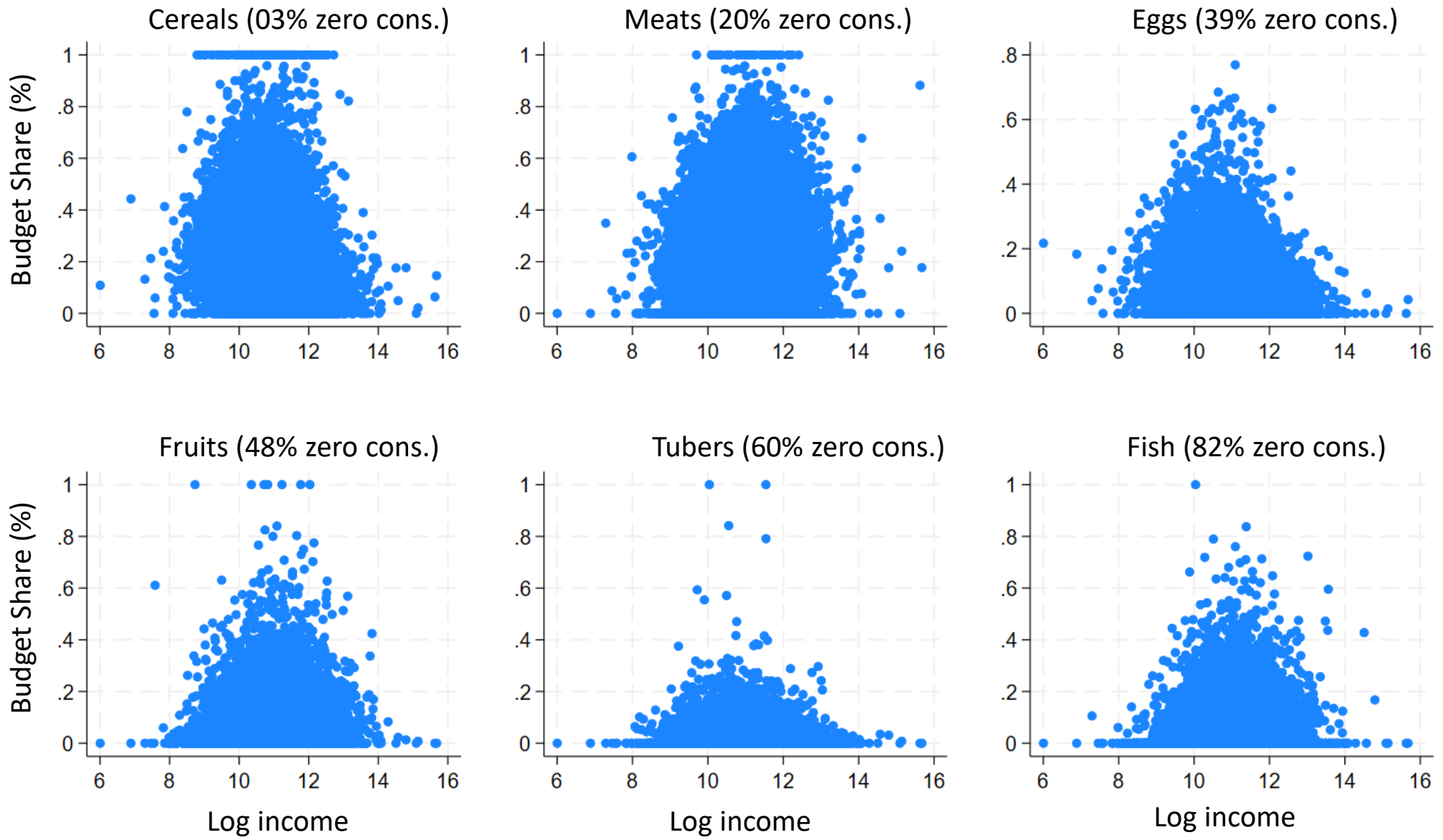
Appendix A. Food group classification based on ENIGH 2022

Food Group	Included Items	ENIGH codes
Cereals	Maize, wheat, rice, and other grain-based products	A001–A024
Meats	Beef, pork, poultry, processed meats, and other meat products	A025–A065
Fish	Fresh and processed fish, shellfish, and other seafood	A066–A074
Dairy	Milk, cheese, yogurt, and other dairy products	A075–A092
Eggs	Eggs	A093–A094
Oils	Edible oils and fats	A095–A100
Tubers	Fresh and processed tuber vegetables	A101–A106
Vegetables	Fresh and processed vegetables, legumes, and edible seeds	A107–A146
Fruits	Fresh fruits	A147–A172
Sugar	Sugar and honey	A173–A175
Coffee	Coffee, tea, chocolate, and related products	A176–A182
Spices	Spices, condiments, seasonings, and sauces	A183–A194
Other Foods	Prepared meals, snacks, desserts, and other ready-to-eat food items	A195–A214, A242
Beverages	Non-alcoholic and alcoholic beverages	A215–A238

Note: The items included in each food group are based on the official expenditure classification from the ENIGH 2022 household survey (INEGI).

Appendix B. Food Budget Shares vs. Log Household Income



Source: Data ENIGH 2022.