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# Poor vs Non-Poor Households in Uruguay: Welfare Differences from Food Price Changes

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## ABSTRACT

Evidence suggests that household responses to price and income changes are significantly sensitive across income levels and rural-urban location. In this paper, we focus on poor households vs. non-poor households using two definitions of poverty, objective and subjective. We evaluate the differential responses of poor households vs. non-poor households to changes in food expenditures and prices and simulate the welfare losses from food price changes across poverty definitions. We use the QUAIDS model to estimate food elasticities with data from the National Expenditure and Household Income Survey, 2016-2017, from Uruguay. Expenditure elasticities at the food level reveal that bread and dairy products are a necessity-food category, regardless of the poverty status and across poverty definitions, while beverages are a luxury good. The demand sensitivity for the rest of the food categories differs by poverty status and poverty definitions. Uncompensated own-price elasticities indicate that when poverty is defined objectively, then changes in demand due to changes in price are greater for poor households (except for meat products). However, poor households, under the subjective definition, are more sensitive than non-poor households only to changes in beverage prices. Additionally, changes in household economic welfare due to price increases vary according to poverty status. On average, the percentage of total income needed to avoid a loss in economic welfare of poor households, defined by the objective method, is double that required by the non-poor households, for all price changes. However, differences are much smaller when using the subjective approach to measure poverty.

**Keywords:** Poverty - Food consumption - Demand system - Welfare- Uruguay

**JEL codes:** D12, I31, I32

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## 1. Introduction

The policy analysis of poverty can be carried out by employing total income or consumption expenditure as indicators. Income measures the real flow of resources to a household, but in consumption-oriented countries, where most of the active population gets resources from agricultural and self-employed activities, food consumption is a more real and robust method of evaluating poverty and welfare levels. Our objective is to evaluate the differential responses of poor households vs. non-poor households to changes in food expenditures and prices, and to simulate the welfare losses from food price changes across two poverty definitions, objective or subjective, using the QUAIDS model. We show that household responses and welfare changes vary, depending on the methodology used to identify the population living in poverty.

Food consumption around the globe is changing rapidly as a consequence of various demand and supply factors. The relevance of food consumption analyses arises from several actual factors: gender and intra-household bargaining power (Gilligan et al., 2020), evaluation of nutrition-assistance programs (Davis et al., 2020), food pricing policies (Wood et al., 2012; Fujii, 2013; Rodriguez-Takeuchi and Imai, 2013), and food tax policies (Xiang et al., 2020). Additionally, recent food patterns imply important changes in the poverty and welfare indicators of the different households (Jayasinghe et al., 2017).

Food consumption is usually analyzed in terms of elasticities, which measure the responses of households to changes in income and prices, with this being an important tool for policy (e.g. Green et al., 2013). A substantial literature on food consumption has used different demand systems to analyze direct and crossed elasticities.<sup>1</sup> The advantage of the demand

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<sup>1</sup> The international literature of food estimations using demand systems is extensive for both developed and developing countries. We cite here, without being exhaustive, one of the most recent papers for each country during the last two decades: Bangladesh (Hul and Arshad, 2010), Bulgaria (Moon et al., 2001), Egypt (Alboghdady and Alashry, 2010), Greece (Klonaris and Hallam, 2003), Korea (Wong and Park, 2018), Italy (Fanelli and Mazzocchi, 2002), Iran (Motallebi and Pendell, 2013), Japan (Price and Gislason, 2001), Jordan (Jabarin, 2005), Malaysia (Sheng et al., 2008), Mexico (Colchero et al., 2015), Netherlands (Mangen and Burrell, 2001), Pakistan (Akram, 2020), Papua New Guinea (Gibson and Rozelle, 2002), Paraguay (Alfonzo and Peterson, 2006), Peru (Gil and Molina, 2005), Saudi Arabia (Selvanathan et al., 2015), Spain (Lasarte et al., 2014), Sri Lanka (Pallegedara, 2019), the UK (Duffy, 2003), the US (Piggott, 2003), Tunisia (Ben Kaabia and Gil, 2001), Turkey (Armagan and Akbay, 2008).

system approach is its consistency with utility-maximization theory and, consequently, the fact that our empirical food elasticity is valid for poverty and welfare analysis.

Why focus on food elasticities and welfare changes for the poor population? Evidence suggests that responses to changes in prices and incomes can be significantly sensitive across income levels (Pinstrup-Andersen and Caicedo, 1978; Park *et al.* 1996; Berges and Casellas, 2007; Ni Mhurchu *et al.*, 2013, Caro *et al.*, 2017). Then, analyzing the effect of economic policies, such as taxes or subsidies, on average elasticities for the population is not likely to be informative if important differences in income distribution exist. At the same time, recent food price increases experienced during economic crises (e.g. in 2008) have raised concerns about their consequences on the economic welfare of poor households, who spend a large portion of their budget on food (Wood *et al.*, 2012; Porto, 2010).

However, when demand analysis aims at understanding the responses of poor households in comparison to the non-poor, the question remains: how to identify poor households? While money-metric measures are widely used, a significant strand of the literature has emphasized the importance of considering subjective assessments of household economic well-being (Ravallion and Lokshin, 2011, 2002; Ravallion, 2012). In this paper, we focus on the intersection of food consumption behavior and poverty measurement, thus covering the gap existing in the extensive food literature. We rely on the National Expenditure and Income Household Survey from Uruguay 2016/2017, because it contains novel information on the subjective poverty status of each household. In addition, Uruguay is an interesting example of a country that exports a food category that is markedly domestically consumed, which may lead to larger welfare losses in the most vulnerable households.

We consider two definitions of poverty: a) an objective measure based on income, and b) a subjective measure based on the household's own perception of its income level. Thus, we separate the sample into two income groups (poor and non-poor) in each poverty definition (objective and subjective). We then estimate a QUAIDS demand system (Banks *et al.*, 1997) for each sub-group considering five aggregated food categories, assuming a two-step estimation (Molina, 1994, 1997). Subsequently, we estimate own price and income elasticities for each sub-group. We then use the estimated own price elasticities to account for differences in welfare measures, across poverty definitions.

Our main contribution lies in an analysis of whether food consumption behavior and welfare losses related to food price changes depend on the definition of poverty. While prior evidence has focused on rural-urban comparisons or differences across income quintiles, we rely on novel information on subjective poverty. We provide the first evidence combining consumption analysis and different methods of measuring the poverty status of households. Estimations allow us to evaluate potential biases arising from the use of these different methods to identify the poor population. The analysis is based on elasticities estimated by a theoretically consistent food demand system (a utility-based structural economic model) and benefits from the flexibility of underlying quadratic Engel curves.

The remainder of the paper is as follows. In Section 2 we describe the food demand characteristics of Uruguay. In Section 3 we present the data, in Section 4 we describe our methodology, and in Section 5 we describe the empirical results. Finally, Section 6 presents our conclusions and policy implications.

## **2. Food demand system in Uruguay**

Uruguay is a consumption-oriented country with approximately 80% of GDP being final consumption expenditure during the last decade (81.421% in 2019), according to the World Bank and OECD National Accounts data. Uruguay is a developing country with upper-middle income, which exhibits a very high per-capita food consumption. In particular, the consumption of beef is one of the highest in the world, matched only by Argentina.

Being an agriculture-based country, and standing out for exporting most of its food production, mainly meat and soybeans, the production of grains for animal feed has grown significantly. The number of Uruguayans potentially fed by national production is 19.4 million. The calories produced for animal feed is 32 % of the total. If all the calories in animal feed were destined directly for human consumption, the number of people fed would be 27.8 million, but due to the loss of efficiency per conversion, 8.4 million fewer people are fed. The food exported by Uruguay is 94 % destined for countries with low (89 %) or moderate (5 %) food insecurity. The national production of fruit and vegetables, available for consumption in the domestic fresh market, is only 50 % of the minimum recommended

consumption for a healthy diet. Such weakness in production, despite there being a surplus in calories, presents imbalances in the type of food produced (Gomez, 2019).

The country finds itself in a demographic post-transition, with a high and rising proportion of individuals over age 65. Additionally, even though the population's educational level is satisfactory, Uruguayans' knowledge, attitudes, and practices concerning food are inadequate; hence, programs of nutritional education for healthy diets should be initiated forcefully and urgently for the entire population. An epidemiological transition also exists, and cardiovascular ailments and cancer have become the primary causes of death in general, and congenital anomalies, which are the primary cause of mortality among children under 5 years old. These problems afflict a small country, with low population density, oriented towards food export, that has improved its macroeconomic indicators in recent years, particularly in terms of the Human Development Index. In 2018, Uruguay ranked 57th in the world by this measure, with one of the lowest levels of poverty in Latin America (UN HDI, 2019).

Recent estimates of food consumption confirm that the population is at high risk of suffering from ailments and obesity caused by (a) excessive energy intake, and (b) high consumption of animal products, particularly beef and dairy products, which translates into a diet rich in fats, of which two-thirds are saturated animal fats. Fish consumption is low, and the consumption of vegetables and fruit has not yet reached acceptable levels, although it is improving.

Ares (2008) studied the motives underlying consumer food choices and examined the consumption frequency of certain selected food items. The most important factors, in terms of food choices, were found to be 'feeling good', food safety, sensory appeal, and health and nutrient content. Using hierarchical cluster analysis, three clusters with different choice patterns were identified. Frequency of consumption of fruit, vegetables, milk and dairy products, and whole cereals, increased as the importance attributed to health and nutrition increased, while consumption of fatty foods decreased. Estrades (2012) applied a general equilibrium model to study the impact of the 2006–2008 food price spike on poverty. Results indicated that extreme poverty increased during those years. As in other countries, the

increase in food prices affects the already-poor population, who become even poorer. This finding highlights the need for policies that mitigate the negative effects of price shocks.

Lanfranco (2014) analyzed the demand for meat at the household level, using an incomplete system of censored demand equations with household data from the last available national income and expenditure survey (2005/06). Thirteen meat products were included in the analysis: six beef products, four products from other meats, and three generic mixed-meat products. All meat items were necessary goods and evidenced income-inelastic responses. All meats behaved as normal goods although exhibiting different reactions to changes in price. In general, beef cuts were more price elastic than other, more broadly defined products. Rossi (2016) studied the influence of sociodemographic characteristics on each of the identified dimensions in Montevideo. A probit model was used to determine the impact of individual and household sociodemographic characteristics on the identified dimensions of food insecurity for adults aged between 18 and 93 years. Results showed that household income had the largest influence on all dimensions, indicating a strong relationship between income and food insecurity.

More recently, Ares (2017) identified the motives underlying food choice and barriers to healthy eating among consumers, on two socioeconomic levels. Eleven focus groups were formed, with a total of 76 participants. Results confirmed the strong influence of income level on food choices, and on barriers to the adoption of healthy eating. Low-income participants described their choices as mainly driven by economic factors and satiety, whereas convenience was the main determinant of food selection for middle-income participants.

### **3. Data**

We use the National Expenditure and Household Income Survey from Uruguay (ENGIH, Spanish acronym), for the years 2016/2017 conducted by the National Institute of Statistics (INE). We use the Uruguayan data because it allows us to exploit novel information on the subjective poverty status of each household. The survey is a cross-sectional survey reporting information at the household level on expenditures, and quantities of all commodities at a

low disaggregation level, as well as socio-economic and demographic characteristics. The survey is nationally representative and comprises a total of 7,500 households, in both urban and rural areas. Because some observations reported incomplete information or zero food purchases, our sample amounts to 6,846 families.

We define five mutually exclusive groups of food and beverages considering the consumption patterns of Uruguayans (Lanfranco and Rava, 2014) and the differences in diet of low- and high-income households: i) bread and dairy products (milk, yogurt, cream, etc.); ii) grains, sugar, oil and flour-based products; iii) meat (all animal-based products); iv) fruit and vegetables; v) beverages (non-alcoholic and alcoholic). Budget shares are calculated as the ratio between the expenditure in each category and total food expenditure (*i.e.*, total expenditure on all 5 categories).

In order to analyze food consumption across income groups, we consider an objective and a subjective definition of poverty at the household level. The objective approach is the official method of computing poverty in Uruguay, which compares total household income to a specific threshold. The threshold is given by the monetary value of a basic basket of food and non-food goods, taking into account family size and economies of scale (INE, 2017). For the subjective measure, the survey directly asks the respondent if “he/she considers that his/her family is poor”. Notable differences are found across poverty measures: according to the objective threshold, 8.1% households are poor, while 36.7% households are self-classified as poor. Despite that Uruguay has a relatively low poverty rate, individual self-assessments of poverty status notably differ from conventional objective measures.

Table 1 reports average food expenditure in each category and the demographic household profile, depending on the poverty status (poor and non-poor) and across poverty definitions (objective and subjective). The composition of food expenditure in shares is very similar between the poor and non-poor population in each poverty definition. The main component of food consumption in Uruguayan families irrespective of their poverty status is meat, representing, on average, 32% of the food budget. Families spend on average 20% of their food budget on bread and dairy products, and a similar percentage on grains, sugar, oil and flour-based products, while household allocate 16% of the food budget fruit and 15% to vegetables and beverages.



**Table 1.** Descriptive statistics by poverty status

	Objective Poverty				Subjective Poverty			
	Poor		Non-Poor		Poor		Non-poor	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Food expenditure (in pesos)	5,108.3	34.04	7,806.5	62.73	5954.9	71.83	8543.2	71.83
<i>Expenditure Shares</i>								
Bread, dairy	0.20	0.004	0.20	0.001	0.19	0.002	0.21	0.002
Grain, sugar, flour, oil	0.19	0.004	0.17	0.001	0.17	0.002	0.17	0.002
Meat	0.32	0.006	0.32	0.002	0.33	0.003	0.31	0.002
Fruit, vegetables	0.16	0.004	0.16	0.001	0.16	0.002	0.16	0.002
Beverages	0.13	0.004	0.15	0.001	0.15	0.002	0.15	0.002
<i>Demographics</i>								
Montevideo	35%	-	34%	-	27%	-	39%	-
Urban > 5,000 inhab.	42%	-	42%	-	44%	-	41%	-
Urban < 5,000 inhab. and rural	23%	-	23%	-	28%	-	20%	-
1 if head is male	50%	-	51%	-	48%	-	51%	-
Age of the head (in years)	53.3	16.8	54.2	16.8	54.3	16.6	52.8	16.9
Household size	2.72	1.49	2.61	1.38	2.81	1.68	2.66	1.36
Number of children	0.51	0.88	0.44	0.80	0.57	0.98	0.47	0.82
Single households	10%	-	23%	-	24%	-	21%	-
%	8.1		91.9		36.9		63.1	
N	556		6,290		2,528		4,318	

#### 4. Empirical Methodology

We first describe the demand system and elasticities, and explain the approach used to construct prices and deal with the potential endogeneity of total expenditure. We then describe the measures used to calculate potential income losses due to changes in food prices.

For estimation purposes, we partition the sample into two income groups (poor and non-poor) in each poverty definition (objective and subjective). Subsequently, we estimate own price and income elasticities for each sub-group. We then use the estimated own price elasticities to estimate welfare changes across poverty definitions.

#### 4.1. Demand System

We estimate a QUAIDS demand system proposed by Banks *et al.* (1997), as a generalization to the AIDS model introduced by Deaton and Muellbauer (1980). This extension incorporates a quadratic logarithm expenditure term in the specification of the system. The QUAIDS approach preserves the consistency in aggregation across consumers of the AIDS lineal model, and allows us to derive flexible price and income responses within a theoretically coherent structure. Models that do not account for the Engel curvature may generate distortions in the patterns of welfare losses associated with price changes (Banks *et al.*, 1997).

In the QUAIDS model, the specification of the budget share equation for each aggregated food category is:

$$w_i = \alpha_i + \sum_j \gamma_{ji} \ln p_j + \beta_i \ln \left( \frac{m}{a(\mathbf{p})} \right) + \frac{\lambda_i}{b(\mathbf{p})} \left( \ln \left( \frac{m}{a(\mathbf{p})} \right) \right)^2 \quad (1)$$

where  $\mathbf{p}$  is the price vector of food categories,  $p_j$  is the price of good  $j$ , and  $m$  is total food expenditure,  $a(\mathbf{p})$  is a transcendental logarithm function and  $b(\mathbf{p})$  is a Cobb-Douglas price aggregator. These price functions are defined as:

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ji} \ln p_i \ln p_j$$

$$b(\mathbf{p}) = \prod_i p_i^{\beta_i}$$

The AIDS model is a particular case of the QUAIDS when  $\lambda_i = 0$ . If the vector  $\lambda$  is statistically equal to zero, then the underlying Engel curves are linear.

Compliance with the properties of the economic demand theory imposes linear constraints on the parameters of the budget share equations. In particular, additivity (Eq. 2), homogeneity of degree zero in prices and income (Eq. 3), and symmetry (Eq. 4)

$$\sum_i \alpha_i = 1; \sum_i \gamma_{ji} = 0; \sum_i \beta_i = 0; \sum_i \lambda_i = 0 \quad (2)$$

$$\sum_j \gamma_{ij} = 0 \quad (3)$$

$$\gamma_{ij} = \gamma_{ji} \quad (4)$$

Following Banks *et al.* (1997), expenditure and price elasticities can be computed after system estimation. Derivation of the share equation with respect to food expenditure and prices is:

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

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

Then, food expenditure elasticities are given by:

$$e_i \equiv \frac{\mu_i}{w_i} + 1 \quad (5)$$

and uncompensated elasticities by:

$$e_{ij} \equiv \frac{\mu_{ij}}{w_i} - \delta_{ij} \quad (6)$$

with  $\delta_{ij} = 0$  if  $i \neq j$   $\delta_{ij} = 1$  if  $i = j$ . Then, according to the Slutsky equation, compensated elasticities can be calculated as:

$$e_{ij}^* \equiv e_{ij} + e_i w_j \quad (7)$$

In addition, observed heterogeneity can be introduced in the demand system by incorporating household demographic characteristics in a theoretically plausible way (Pollak and Wales 1981; Lewbel, 1985; Perali, 2003). We specify demographic variables implementing a translating household technology  $t_i(\mathbf{d})$ , so that demographic characteristics interact additively with income (*i.e.*, as if they were fixed costs deflating income), where  $\mathbf{d}$  is a set of household characteristics. Then, the demographically modified food expenditure is  $\ln m^* = \ln m - \sum_i t_i(\mathbf{d}) \ln p_i$ , where the asterisk indicates demographically modified variables. The demographically modified budget share equation is<sup>2</sup>:

$$w_i = \alpha_i + t_i(\mathbf{d}) + \sum_j \gamma_{ji} \ln p_j + \beta_i \ln \left( \frac{m^*}{a(p)} \right) + \frac{\lambda_i}{b(p)} \left( \ln \left( \frac{m^*}{a(p)} \right) \right)^2 \quad (8)$$

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<sup>2</sup> To ensure that the modified cost function maintains the homogeneity property, an additional constraint is imposed (Perali, 2003).

The demographic variables used in the system are regions (Montevideo, urban areas with more than 5,000 inhabitants, and urban and rural areas with less than 5,000 inhabitants), age and gender of the head of the household, family size, number of children and an indicator variable for single households.

For the estimation, an error term  $\epsilon_i$  is added to the right-hand side of Eq. (8). The vector  $\epsilon$  of error terms is assumed to have a multivariate normal distribution with covariance matrix  $\Sigma$ . One of the budget share equations is dropped from the system estimation because  $\Sigma$  is singular, in order to comply with the adding-up condition. After estimation, the parameters of the dropped equation are recovered, following the restrictions imposed. The system is estimated by Maximum Likelihood, and elasticities in Eq. (5), (6) and (7) are modified by the translating household technology.

#### ***4.2. Adjusted Unit Values and Endogeneity of Total Expenditure***

Estimation of demand systems requires us to tackle two important issues. First, prices are needed to completely model household consumption behavior and assess welfare changes. In addition, the endogeneity of total expenditure must be addressed.<sup>3</sup>

By exploiting the quantity information available in the data-set, we compute unit values (implicit prices) as the ratio of expenditure to quantity, for each food category of the system. However, unit values can be endogenous because of measurement error, aggregation problems, and quality effects related to heterogeneity in preferences (Prais and Houthakker, 1955; Cox and Wohlgenant, 1986; Deaton, 1988). Because the same food commodity is generally available at different price and quality levels, unit values do not take into account possible changes of the composite good. Then, price elasticities can be biased. Solutions to this endogeneity problem typically assume that geographically clustered households face similar prices. In this way, unit values within regions cancel-out quality, aggregation, and measurement errors (Capacci and Mazzocchi, 2011).

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<sup>3</sup> Another important issue in demand analysis is the treatment of zero expenditures. However, given the definition of our food categories, as in Wood *et al.* (2012), we do not face this econometric problem. The percentage of zero expenditure in each of the five food categories is sufficiently small.

We compute quality-adjusted implicit prices following Cox and Wohlgenant (1986). In this approach, real deviations from regional mean prices (*RDMP*) are assumed to reflect the quality effects induced by household characteristics. Then, price functions are specified as:

$$RDMP_i = p_i - \alpha_i = \sum_j \theta_{ij} b_{ij} + \zeta_i \quad (11)$$

where  $\alpha_i$  is the regional mean price and  $b_{ij}$  are household characteristics that serve as proxies for household preferences for unobserved quality. Changes in the deviations from regional mean prices are explained by the variation of quality characteristics. Then, quality-adjusted implicit prices are calculated as:

$$p_i^* = \alpha_i + \zeta_i \quad (12)$$

where  $\zeta_i$  is the residual from Eq. (11).

For the estimation, we use characteristics of the household head (age, gender, and educational level), family size, an indicator for the presence of children, and total income and its square (to capture increases in quality with income level). To account for regions, we use the lower level of disaggregation available in the data-set (“*departamentos*”). Table 2 reports the descriptive statistics of estimated quality-adjusted prices for each sub-group. For all sub-groups, fruit and vegetables along with bread and dairy products exhibit the lowest prices on average, while beverages is the relatively most expensive aggregate commodity. In addition, bread and dairy products, meat, and fruit and vegetables have lower mean prices for the poor population, regardless of the poverty definition, while beverages are substantially more expensive.

Potential endogeneity of total expenditure also needs to be addressed. Expenditure may be endogenous because budget shares and total expenditure are mutually determined. In this sense, total expenditure could be endogenous if taste shocks (residuals in the demand system equations) that determine total expenditure are correlated with the unobserved taste shocks to a particular budget share in the system, or if measurement (or recall) errors in the budget shares are correlated with measurement (or recall) errors in total expenditure.

**Table 2.** Adjusted unit values

	Objective Poverty				Subjective Poverty			
	Poor		Non-Poor		Poor		Non-poor	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Bread, dairy	0.37	0.12	0.56	0.21	0.38	0.16	0.61	0.23
Grain, sugar, flour	3.37	2.08	1.57	1.71	1.36	1.28	1.99	1.78
Meat	1.20	0.35	1.32	0.51	1.01	0.46	1.43	0.53
Fruit, vegetables	0.28	0.10	0.34	0.14	0.31	0.13	0.35	0.15
Beverages	12.4	5.30	2.65	3.05	12.1	14.4	3.42	2.82
N	556		6,290		2,528		4,318	

Note: Food prices in pesos.

We instrument total expenditure with the logarithm of total income and its square, assuming that it provides a source of exogenous variation explaining the cross-sectional variability of total expenditure, but without being correlated with taste variables and measurement errors.<sup>4</sup> We use the control function approach originally proposed by Blundell and Powell (2004), because the use of the first stage prediction in place of the endogenous variable in non-linear models is biased and inconsistent (Terza *et al.*, 2008). The approach consists of a two-stage procedure. In the first stage, we regress all covariates of the system (prices and demographic variables) and the instrument on total expenditure, in order to predict the residuals (denoted as  $v_i$ ). In the second stage, the residuals of the auxiliary regression are included in the system specified in Eq. (8). The control function approach gives a straightforward test for endogeneity by assessing the significance of the coefficients associated with the predicted residuals (of the first stage) in the system equations. If the coefficients are statistically different from zero, then the unexplained variation of the endogenous variable also affects the variations in demand, implying endogeneity of total food expenditure (

### 4.3. Welfare Effects of Price Changes

Changes in prices typically affect household economic welfare, and policy analysis requires quantifying these potential changes. If food prices increase, household real income declines.<sup>5</sup>

<sup>4</sup> We also use an index for access to basic amenities as alternative instrument, as in Caro *et al.* (2017) and Segovia *et al.* (2020). Even though system parameters are robust, total income is a stronger instrument in the context of our data.

<sup>5</sup> Income and expenditure are interchangeably used in demand analysis as a money metric of welfare. On the other hand, the use of income as a welfare measure introduces the need to account for savings.

Then, the interest resides in the calculation of income losses. Estimations of consumption behavior allow us to analyze the welfare effects of price changes. Based on Hick's (1946) concept of the expenditure function (*i.e.* the minimum cost of attaining a given utility level  $u$  at price  $\mathbf{p}$ ), the compensating variation (CV) measures the change in real income required to compensate the household after a price change, so that the household is able to restore the initial utility level while facing the new prices. In the consumption literature, compensating variation capturing welfare effects is measured by a first-order and second-order Taylor expansion of the minimum expenditure function (*e.g.* Friedman and Levinsohn, 2002; Son and Kakwani, 2009; Porto, 2010; Wood *et al.*, 2012; Badolo and Traore, 2015). First-order approximations of welfare effects in terms of budget shares and proportional price changes are defined as:  $CV \approx \sum_i w_i (dlnp_i)$  (9)

where  $i$  refers to the food category of the demand system and  $w_i$  is the budget share before the price change. This measure of welfare effects is driven by budget shares and assumes that households do not react to price changes by substituting to relatively less costly products, implying that household consumption behavior remains unaltered after the price change. Even though this can be overly restrictive, the measure can be thought of as a short-run effect of prices changes.

To account for potential household behavioral responses in welfare analysis, substitution effects can be taken into consideration by a second-order approximation of welfare effects in terms of budget shares and proportional price changes:

$$cv \approx \sum_i w_i (dlnp_i) + \frac{1}{2} \sum_i \sum_j w_i e_{ij}^* (dlnp_i)(dlnp_j) \quad (10)$$

where  $e_{ij}^*$  are compensated price elasticities. Note that the first term corresponds to the first-order approximation while the second term captures substitution effects. Then, the effect of a price change on household economic welfare depends on the relative importance of each good in the household consumption basket, on the compensated price elasticities, and on the magnitude of the price change. Since allowing for consumption responses makes the losses lower, first-order approximations provide a maximum bound on the impact of price changes.

## 5. Results

We estimate the demand system specified in Eq. (8), augmented to account for the potential endogeneity of total expenditure, as explained in Section 4, for each poverty status (poor and non-poor population) and poverty definition (objective and subjective). The system estimates 54 parameters for each sub-group. Because not all system parameters have a direct interpretation, we only report (Table A.1. of the Appendix) the estimates related to the quadratic term ( $\lambda_i$ ) and the residuals of the first stage of the control function included in the system ( $v_i$ ). Most (85%) of the income quadratic parameters are statistically significant, indicating that the underlying Engel Curves are non-linear in income, and that the quadratic specification provides a good fit. In addition, most (65%) of the estimates associated with the residuals are statistically significant, indicating that total food expenditure is endogenous.

Using the system parameters, we compute expenditure elasticities (Table 3) and compensated and uncompensated own-price<sup>6</sup> elasticities (Table 4) by poverty status and poverty definition. Elasticities represent household responses to price and expenditure changes.

Panel (A) of Table 3 reports the expenditure elasticities at the food level, derived from system estimates, and representing the sensitivity of demand for each food category with respect to total food expenditure. These elasticities reveal that none of the goods are inferior. Bread and dairy products are a necessity food category regardless of the poverty status and across poverty definitions, while beverages are a luxury good. The sensitivity of demand for the rest of the food categories with respect to food expenditure differs across poverty status and poverty definitions.

However, total income (and not food expenditure) elasticities are at the center of policy discussions. Following Manser (1976) and Park *et al.* (1996), we compute an estimate of the demand elasticity with respect to total income ( $e_i^I$ ) reported in Panel (B). These elasticities are obtained by multiplying the food expenditure elasticity of each category ( $e_i$ ) reported in Panel (A) by an estimate of the food elasticity with respect to total income ( $e^I$ ). The estimate of the latter can be retrieved through an auxiliary regression of food expenditure on income for each sub-group.

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<sup>6</sup> We focus on own-price elasticity because these elasticities are used to estimate welfare losses due to changes in price.



Income elasticities shown in Panel (B) are naturally lower than food expenditure elasticities in Panel (A). Because all elasticities are below one, the broad food group is considered a necessity for all sub-groups. Income elasticities are larger for the poor population, indicating that poor households are more responsive to changes in income than non-poor households. This result holds for both poverty definitions. Bread and dairy is the most necessary category for the poor population, regardless of the method of computing poverty. However, the more income elastic categories for poor households, identified by the objective method, are grain, flour and sugar products along with fruit and vegetables, while for subjectively poor households the largest elasticities are for meat and beverages.

Differential demand for quality by poor and non-poor households is implied by the differences between the income and expenditure elasticities. The difference between these estimates represents the elasticity of quality as the increase in quality (represented by the increase in the unit price) follows what individuals are willing to buy as incomes increase.

Under the objective (subjective) definition of poverty, households have a higher demand for quality in grain, flour, and sugar (meat) products. At the same time, demand for quality is higher for non-poor households, according to both definitions of poverty. However, considering the objective definition of poverty, demand for quality is markedly higher for bread and dairy products, meat and beverages, while in the case of the subjective definition of poverty, demand for quality is relatively higher for grain, flour and sugar, and meat.

**Table 3.** Estimated Expenditure and Income Elasticities by Poverty Status

	(A): Food Expenditure Elasticities				(B): Income Elasticities			
	Objective		Subjective		Objective		Subjective	
	Poor	Non-poor	Poor	Non-poor	Poor	Non-poor	Poor	Non-poor
Bread, dairy	0.756*** (0.166)	0.966*** (0.050)	0.909*** (0.071)	0.649 (0.900)	0.556*** (0.038)	0.523*** (0.010)	0.594*** (0.018)	0.331*** (0.008)
Grain, flour, sugar	1.189*** (0.017)	1.004*** (0.011)	0.925*** (0.009)	1.075*** (0.013)	0.874*** (0.059)	0.543*** (0.011)	0.604*** (0.019)	0.549*** (0.014)
Meat	0.952*** (0.037)	0.977*** (0.029)	1.083*** (0.018)	1.152*** (0.020)	0.700*** (0.047)	0.529*** (0.010)	0.708*** (0.022)	0.588*** (0.015)
Fruit, vegetables	1.116*** (0.053)	0.968*** (0.016)	0.940*** (0.036)	0.947*** (0.019)	0.821*** (0.056)	0.524*** (0.011)	0.614*** (0.019)	0.483*** (0.012)
Beverages	1.037***	1.120***	1.074***	1.089***	0.757***	0.606***	0.702***	0.556***

(0.007) (0.029) (0.018) (0.015) (0.051) (0.012) (0.022) (0.014)

Note: Panel (A) reports food expenditure elasticities obtained from system estimates. Panel (B) reports income elasticities obtained by multiplying the food expenditure elasticity of each category of Panel (A) by an estimate of the food elasticity with respect to total income. All elasticities are computed at the mean values of the variables. Bootstrapped standard errors in parenthesis. \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.

Panel (A) of Table 4 shows the uncompensated own-price elasticities. All elasticities are significant, with the exception of bread and dairy products. Because the own-price elasticities of bread and dairy products are not significantly different from zero for poor households, then the Marshallian demands for bread and dairy products are perfectly inelastic. This is probably related to the fact that it is a staple good for poor households. In addition, price elasticities of beverages and grain, flour and sugar are close to one for all sub-groups, implying that the percentage change in demand is proportional to the percentage change in price. Further, if poverty is defined by the objective method, then changes in demand due to changes in prices are greater for poor households, except for meat products. However, poor households, according to the subjective definition, are more sensitive than non-poor households, only due to changes in beverage prices.

Panel (B) of Table 3 shows pure substitution effects. The signs of all own-price compensated elasticities are consistent with the economic theory. The smallest compensated elasticities correspond to the meat category, indicating that all households react significantly less to changes in the price of meat than to any other price change. For example, an increase of 10% in the price of meat decreases the demand for meat of poor households by 3.5% or 4.6% according to the definition of poverty, while an increase of the same proportion in the category of grain, flour and sugar, decreases their demand by 8% or 7.4%. In addition, poor households, both objectively and subjectively defined, have an even more inelastic response to changes in meat prices compared to non-poor households. This result is important for the analysis of welfare losses due to price changes that follows.

**Table 4.** Estimated own-price elasticities by poverty status

(A): Uncompensated Elasticities				(B): Compensated Elasticities			
Objective		Subjective		Objective		Subjective	
Poor	Non-poor	Poor	Non-poor	Poor	Non-poor	Poor	Non-poor

Bread, dairy	-0.289 (0.706)	-0.670* (0.300)	-0.642 (0.431)	-0.522 (1.477)	-0.130 (0.685)	-0.477 (0.270)	-0.472 (0.410)	-0.379 (1.475)
Grain, flour, sugar	-1.027*** (0.046)	-0.929*** (0.061)	-0.909*** (0.076)	-0.974*** (0.057)	-0.800*** (0.127)	-0.760*** (0.079)	-0.748*** (0.080)	-0.792*** (0.100)
Meat	-0.655*** (0.175)	-0.858*** (0.147)	-0.820*** (0.154)	-0.939*** (0.115)	-0.353* (0.153)	-0.547** (0.171)	-0.467** (0.142)	-0.579*** (0.165)
Fruit, vegetables	-0.947*** (0.187)	-0.863*** (0.126)	-0.838*** (0.171)	-0.893*** (0.113)	-0.772*** (0.189)	-0.706*** (0.064)	-0.684*** (0.122)	-0.741*** (0.079)
Beverages	-1.021*** (0.050)	-1.022*** (0.057)	-1.043*** (0.085)	-0.927*** (0.107)	-0.882*** (0.134)	-0.852*** (0.124)	-0.880*** (0.135)	-0.764*** (0.097)

Note: Uncompensated and compensated own-price elasticities computed at the mean values of the variables. Bootstrapped standard errors in parenthesis. \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.

We now simulate the effect of a 25% and a 50% price increase on household economic welfare, following the analysis of Wood et al. (2012) for Mexico after the significant food price spike of 2008. Table 5 shows the average welfare losses (compensating variations) of a 25% and 50% increase in the price of relevant food categories by poverty status and poverty definition. Panel (A) reports the first-order approximation of welfare losses as a percentage of food expenditure (see Eq. 9), representing the immediate (short-run) effects of changes in prices. Panel (B) reports the second-order approximation of welfare losses as a percentage of food expenditure (see Eq. 10), allowing for behavioral responses of the household through substitution effects. Each price increase assumes that the rest of the prices remain unchanged. As expected, average welfare losses captured by first-order approximation are larger.

**Table 5.** Welfare losses as a proportion of food expenditure by poverty status (%)

	(A): First-order approximation				(B): Second-order approximation			
	Objective		Subjective		Objective		Subjective	
	Poor	Non-poor	Poor	Non-poor	Poor	Non-poor	Poor	Non-poor
25% increase								
Bread, dairy	5.0*** (0.123)	4.9*** (0.032)	4.6*** (0.048)	5.2*** (0.038)	4.9*** (0.121)	4.6*** (0.033)	4.4*** (0.043)	4.9*** (0.038)
Grain, flour, sugar	4.8*** (0.105)	4.2*** (0.033)	4.3*** (0.053)	4.2*** (0.040)	4.3*** (0.105)	3.8*** (0.027)	3.9*** (0.051)	3.8*** (0.035)
Meat	8.0*** (0.150)	7.9*** (0.052)	8.1*** (0.079)	7.8*** (0.057)	7.6*** (0.147)	7.4*** (0.048)	7.7*** (0.079)	7.3*** (0.054)

Fruit, vegetables	3.9*** (0.108)	4.1*** (0.030)	4.1*** (0.051)	4.0*** (0.035)	3.5*** (0.096)	3.7*** (0.029)	3.7*** (0.049)	3.6*** (0.031)
50% increase								
Bread, dairy	10.0*** (0.243)	9.9*** (0.059)	9.2*** (0.094)	10.3*** (0.081)	9.7*** (0.205)	8.7*** (0.057)	8.2*** (0.085)	9.3*** (0.066)
Grain, flour, sugar	9.5*** (0.128)	8.5*** (0.068)	8.7*** (0.109)	8.5*** (0.076)	7.6*** (0.191)	6.8*** (0.048)	7.1*** (0.093)	6.8*** (0.060)
Meat	15.9*** (0.328)	15.9*** (0.101)	16.3*** (0.155)	15.7*** (0.115)	14.5*** (0.294)	13.7*** (0.081)	14.4*** (0.147)	13.4*** (0.100)
Fruit, vegetables	7.8*** (0.226)	8.1*** (0.058)	8.2*** (0.117)	8.03*** (0.701)	6.3*** (0.153)	6.7*** (0.055)	6.8*** (0.077)	6.5*** (0.057)

Note: Panel (A) reports the first-order approximation of welfare losses as a percentage of food expenditure (Eq. 9). Panel (B) reports the second-order approximation of welfare losses as a percentage of food expenditure (Eq. 10). Bootstrapped standard errors in parenthesis. \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.

The average percentage change required in food expenditure to restore the initial welfare, given new prices, is relatively similar across poverty status and poverty definition.<sup>7</sup> Larger welfare losses are associated with changes in the price of meat. For example, considering substitution effects, poor households would need to be compensated with an increase of 7.6% or 7.7% of their food budget, according to the definition of poverty, if the price of meat increases by 25%. In addition, the largest differences in welfare effects between the poor and non-poor are given by the grain, flour and sugar category for the objective poverty method, and by bread and dairy for the subjective poverty method.

**Table 6.** Welfare losses as a proportion of total income by poverty status (%)

	Objective		Subjective	
	Poor	Non-poor	Poor	Non-poor
25% increase				
	1.2*** (0.040)	0.6*** (0.006)	0.7*** (0.009)	0.6*** (0.007)
Grain, flour, sugar	1.1*** (0.043)	0.5*** (0.005)	0.6*** (0.103)	0.4*** (0.008)
Meat	1.9*** (0.076)	0.9*** (0.010)	1.1*** (0.019)	0.8*** (0.013)

<sup>7</sup> The magnitude of the changes in absolute levels will differ because they vary with income level.

Fruit, vegetables	0.9*** (0.034)	0.5*** (0.005)	0.6*** (0.009)	0.4*** (0.005)
50% increase				
Bread, dairy	2.4*** (0.081)	1.0*** (0.013)	1.2*** (0.017)	1.1*** (0.014)
Grain, flour, sugar	1.9*** (0.070)	0.8*** (0.010)	1.1*** (0.018)	0.8*** (0.012)
Meat	3.6*** (0.140)	1.6*** (0.021)	2.2*** (0.035)	1.5*** (0.021)
Fruit, vegetables	1.6*** (0.065)	0.8*** (0.009)	1.0*** (0.015)	0.7*** (0.011)

Note: Second-order approximation of welfare losses as a percentage of total income.

Bootstrapped standard errors in parenthesis \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.

Table 6 reports average welfare losses (based on the second-order approximation) as a proportion of total income, by poverty status and poverty definition. Results indicate that the magnitude of the average welfare change varies with the poverty status. On average, the percentage compensation of total income needed to avoid a loss in economic welfare of poor households, defined by the objective method, is twice the compensation required by the non-poor households, at all price changes. Differences are much smaller when using the subjective approach to measure poverty. As a consequence, price changes of all food categories considered are anti-poor in the sense that the magnitude of the percentage reduction in income decreases by poor and non-poor status. This result holds for both poverty definitions.

## 6. Conclusions and policy implications

In this paper, we have derived food elasticities for poor and non-poor Uruguayan households, adopting objective and subjective definitions of poverty, and we have simulated the effect of price changes on household economic welfare. This analysis allows us to evaluate potential biases arising from the use of different methods to identify the poor population. We have considered two definitions of poverty: an objective measure based on income, and a subjective measure based on a self-assessment of income. To this end, we have employed the

National Expenditure and Household Income Survey from Uruguay (2016/2017) in order to exploit novel information on subjective poverty. We estimate a QUAIDS demand system for five food categories for poor and non-poor households in each poverty definition (objective and subjective).

Expenditure elasticities at the food level reveal that bread and dairy products are necessity foods regardless of the poverty status and across poverty definitions, while beverages are a luxury good. The sensitivity of demand for the rest of the food categories with respect to food expenditure differs across poverty status and poverty definitions. Income elasticities indicate that poor households are more responsive to changes in income than non-poor households, for both poverty definitions. Uncompensated own-price elasticities indicate that when poverty is defined by the objective method, then changes in demand due to changes in price are larger for poor households, except for meat products. However, poor households, according to the subjective definition, are more sensitive than non-poor households only due to changes in beverage prices. With respect to pure substitution effects, compensated elasticities indicate that all households react significantly less to changes in the price of meat than to any other price change. In addition, poor households, both objectively and subjectively defined, have an even more inelastic response to changes in meat prices, compared to non-poor households.

The analysis of the effect of simulated price changes on household economic welfare shows that the magnitude of the average welfare change (based on the second-order approximations) varies with poverty status. On average, the percentage compensation of total income needed to avoid a loss in economic welfare of poor households, defined by the objective method, is twice the compensation required by the non-poor households, at all price changes. Differences are much smaller when using the subjective approach to measure poverty. As a consequence, price changes of all food categories are anti-poor, in the sense that the magnitude of the percentage reduction in income decreases by poor and non-poor status. This result holds for both poverty definitions.

Our results have important policy implications for countries that export a food category consumed domestically. Uruguay exports 75% of its meat production and, at the same time, meat consumption is the main component of the family food basket. Meat price increases in

the domestic market because of the external demand. Then, larger welfare losses are observed in poor households, which holds independently of how we define poverty.

Additionally, our results have clear implications for the nutritional status of poor households. Uruguay has three types of nutritional problem of the middle- and low-income populations (FAO, 2010), which can be partially addressed from our empirical results. First, there are problems that affect specific groups, i.e. energy and protein malnutrition found among children under 5 years old belonging to indigent or below-poverty-line households. Second, there are the problems of excess, such as obesity, which are quite prevalent, placing the entire country's population at risk regardless of age or socio-economic status, although the most affected groups are adults and the aged. This problem is aggravated by its association with degenerative diseases (cardiac, osteoarticular, digestive, diabetes, etc.). Finally, there exists a group of nutritional problems with unknown prevalence, such as nutritional anaemia and vitamin A deficiency, especially among children under 2 years old and women of child-bearing age. Our empirical results provide guidelines to improve the nutritional status of Uruguayans.

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## Appendix

**Table A.1. Relevant Sub-Set of System Parameters**

	Objective Poverty				Subjective Poverty			
	Poor		Non-Poor		Poor		Non-poor	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
quadratic income term								
$\lambda_1$	0.0181***	0.0031	0.0088***	0.0008	0.0118***	0.0012	0.010***	0.0008
$\lambda_2$	0.0009	0.0025	-0.0018*	0.0010	0.0013	0.0015	-0.002**	0.0009
$\lambda_3$	-0.0115***	0.0039	-0.0082***	0.0014	-0.0038*	0.0020	-0.003***	0.0013
$\lambda_4$	-0.0078***	0.0026	-0.0022*	0.0011	-0.0059***	0.0017	-0.002***	0.0011
$\lambda_5$	0.0002	0.0021	0.0035***	0.0008	-0.0034**	0.0016	-0.002**	0.0011
residuals of the control function								
$v_1$	-0.0331*	0.0174	-0.0330***	0.0045	-0.0379***	0.0069	0.0335***	0.0076
$v_2$	-0.0218	0.0205	0.0119**	0.0048	0.0170**	0.0086	0.0036	0.0075
$v_3$	0.0913***	0.0287	0.0651***	0.0069	0.0546***	0.0119	-0.0129	0.0109
$v_4$	-0.0256	0.0197	-0.0174***	0.0045	-0.0122	0.0080	-0.0107	0.0071
$v_5$	-0.0106	0.0170	-0.0265***	0.0046	-0.0215***	0.0079	-0.0134*	0.0074

Note: Bootstrapped standard errors. \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.