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Maceira, Daniel and Palacios, Alfredo and Espinola, Natalia
and Mejía, Raúl

Center for the Study of State and Society (CEDES), National
Council of Scientific and Technical Research (CONICET),
Department of Economics, University of Buenos Aires (FCE-UBA),
Department of Economics, National University of La Plata
(FCE-UNLP), Hospital de Clínicas, University of Buenos Aires
(UBA)

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Palacios Alfredo
Maceira Daniel
Espinola Natalia
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Daniel Maceira^{1,2,3}, Alfredo Palacios^{1,3}, Natalia Espinola^{1,3,4}, Raúl Mejía^{1,5}

¹ Center for the Study of State and Society (CEDES)

² National Council of Scientific and Technical Research (CONICET)

³ Department of Economics, University of Buenos Aires (FCE-UBA)

⁴ Department of Economics, National University of La Plata

⁵ Hospital de Clínicas, University of Buenos Aires

Corresponding author: Daniel Maceira. Sánchez de Bustamante 27, Buenos Aires, Argentina. Email: danielmaceira@cedes.org

Abstract

Background: Currently there is an important debate in Argentina about the health and economic burden associated with chronic non-communicable diseases, and the potential impact associated with the high consumption of sugar-sweetened beverages (SSB) in children and adults. The objective of this study is to assess the consumption of SSB in Argentina, to estimate the own price, cross-price and income elasticity of the demand for each type of beverage, and to simulate the effect of a price increase via taxes on the quantities consumed.

Methods: Household micro-data was used to determine expenditure, purchased quantities, and implicit prices of different types of beverages (sodas, flavored waters, juices, etc.). This information was taken from the National Household Expenditure Survey (ENGHo) 2004/2005 and 2012/2013. Own price, cross price and income elasticity were estimated using the Almost Ideal Demand System (AIDS).

Results: The own price elasticity of SSB presented values ranged between -1.10 and -1.15 (depending on the household income quintile). Therefore, if price increases of 10% via taxes, the quantity consumed of these beverages would be reduced between 11.0 and 11.5%. The income elasticity of the demand for SSB was estimated between 0.95 and 0.99, which implies that with an increase of 10% of household income, the quantity demanded increases between 9.5 and 9.9% (depending on the household income quintile).

Conclusions: The consumption of SSB is sensitive to the increase in prices in Argentina. From a public health perspective, this suggests that a tax policy for these beverages would have a positive and effective effect in reducing their consumption.

Keywords: Price elasticity, Obesity, Soft drinks, Sugar sweetened beverages, Argentina.

1. Background

Chronic non-communicable diseases (NCDs) were responsible for more than 50% of the total global disease burden in 2013 and represent a greater proportion of the population's health and morbidity loss in past decades [1]. Approximately 80% of premature deaths caused by NCDs occurred in middle and low-income countries [2], which implies significant economic challenges on their health systems and societies [3–5].

Obesity is considered a significant determinant of the burden of disease attributable to NCDs. In 2015, approximately 110 million children and more than 600 million adults were obese, and the prevalence of obesity has doubled in more than 70 countries, while in others it has had an increasing trend [6]. Obese children are at higher risk of developing type 2 diabetes, high blood pressure, asthma, sleep disorders, low self-esteem and depression, while adults are more likely to develop cardiovascular diseases and cancers related to obesity [7–9].

Changes in dietary patterns and physical activity are considered factors that have led to an increase in body weight and metabolic diseases [10,11]. Particularly, foods and beverages with high sugar content constitute one of the largest sources of calories in children and young adults [12]. Globally, it is estimated that 184,000 deaths per year could be attributed to the consumption of sugar sweetened beverages (SSB): 133,000 due to diabetes, 45,000 due to cardiovascular disease and 6,450 due to cancer [13]. In general, the consumption of these types of drinks is higher in younger age and lower income groups [13].

These indicators support the debate about implementing policy measures to prevent and reduce their consumption, which include the reduction of advertising, labeling, and the strengthening of health services, among others. As part of this set of alternatives, the price increase of sugar-sweetened beverages through taxes is one of the most cost-effective interventions to reduce their consumption [14,15].

Latin American countries are among those with the highest per capita consumption of SSB, where Argentina ranks first, with 154.6 liters per inhabitant per year in 2014 [16]. Likewise, the prevalence of obesity in adults and children is particularly high, with Argentina being among the ten countries with the highest adult obesity in the world, with a prevalence of 20.8% [17]. Additionally, the affordability of soft drinks is particularly high in Latin American countries. Within the group of medium income countries worldwide, Argentina ranks third in terms of affordability of soft drinks, followed closely by Mexico and Brazil [18], providing the rationale to move forward with a tax policy initiative on SSB to discourage consumption.

A fundamental element to design an effective tax policy is the estimation of the demand price elasticities for such type of drinks, showing the responsiveness of quantities demanded when price changes. More precisely, it provides the percentage change in quantity demanded in response to a one percent change in price.

Studies performed by Finkelstein [19], Smith [20] and Lin [21] estimate own price elasticity of demand for SSB, reaching approximately -1.3 for the United States; that is, in the face of a 10% increase in the price of SSB, their consumption falls by approximately 13%. Few studies have addressed the estimation of the price

elasticity of demand for SSB in Latin America. Among them, Colchero [22] and Barquera [23] for the Mexican case; Paraje [24] for Ecuador; Guerrero-López [25] for Chile, and Claro [26] for Brazil. In these studies, the estimates of price elasticity of demand for sugar-sweetened beverages (SSB) vary from -0.85 to -1.37. The differences between these estimates involve not only the idiosyncratic characteristics of each country, but additionally the heterogeneity in the availability of sources of information and the estimation methods. The objective of this study is to assess the consumption of SSB in Argentina, to estimate the own price elasticity of demand by the type of SSB (sodas, juices, flavored waters, etc.), as well as the cross-price elasticity between beverages (how the quantity demanded of a type of drink varies with a price change of another beverage), and the income elasticity of demand (how the quantity demanded of a type of drink varies with a change in household income), and to simulate the effect of a price increase via taxes on the quantities consumed.

2. Methods

2.1. Data

Cross-section data at a household level were obtained from the National Household Expenditure Survey (ENGHo) for the period of 2004/2005 and 2012/2013 [27,28]. The ENGHo is planned, organized and supervised by the National Institute of Statistics and Census (INDEC), in collaboration with the Provincial Statistics Offices. The objectives of this survey are to provide information regarding the living conditions of households and the population in general, and the destination of their income in the acquisition of goods and services.

The ENGHo 2004/2005 was conducted in urban and rural settings throughout the country, between October 2004 and December 2005, while the ENGHo 2012/2013 survey was conducted between March 2012 and March 2013. Both Surveys were implemented by applying a probabilistic, multi-stage and stratified sample. In ENGHo 2004/2005, a sample of 28,652 households was surveyed, while in ENGHo 2012/2013, 20,652 households were analyzed across the country. In both cases, units of observation were private households. "Private home" is considered to be constituted by any person or group of people, relatives or not, who live in the same dwelling under a family-type regime, and who consume food from the same budget. The criteria for recording expenses is that of acquisition, therefore, the value of the goods and services of which the household takes possession (or acquires the right to receive) during the reference period is recorded regardless of when the home completes the purchase, and the period of consumption [27,28].

The survey identifies the monetary expenditure made by the household, and the quantities available for consumption for different types of non-alcoholic beverages. Among them are sodas, flavored waters, fresh juices, concentrated juices, powdered juices, mineral water, and carbonated mineral water. This level of disaggregation of non-alcoholic beverages by type is relevant facing a differentiated tax policy discussion at product level, according to the type of beverage (beverages with different amounts of added sugar, beverages

with and without prior taxes, etc.). Expenditures are weekly registered and expanded by month. All expenses are expressed in 2013 Argentinean pesos.

The information available on the household's monetary expenditure for each type of non-alcoholic beverage, and the quantity available for consumption of each of them allows the construction of the so-called implicit prices per liter of each beverage type, regardless its presentation (small/large bottles, etc.).

2.2. Empirical model

As in other regional studies that estimate the price elasticity of demand based on household survey data [22,24,25], we use the Almost Ideal Demand System (AIDS) for the estimation of elasticities [29].

The AIDS method meets the axioms of consumer choice, allows the aggregation of consumers, its functional form is consistent with data from household surveys, and it is simple to estimate. The authors consider a specific class of preferences, called PIGLOG [30,31], where the market demand arises as a result of the decisions of a representative rational consumer (thus allowing aggregation). These preferences are represented through the cost or expenditure function that defines the minimum expenditure necessary to obtain a defined level of utility, based on current prices.

From the formal point of view, the obtaining of the own price, cross-price and income elasticity implies the estimation of a system of equations of the type:

$$w_{ihct} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jct} + \beta_i \ln \left(\frac{x}{P_1} \right) + \sum_k \gamma_{ik} \eta_{hctk} + u_{ihct}$$

where w_{ihct} is the proportion of expenditure on good i in the household h living in cluster c during period t , p_{jct} is the price of good j in cluster c in period t , x is the total household expenditure, η_{hctk} account for variables at household level h living in cluster c , P_1 is a price index defined by:

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j \quad (9)$$

Another option, widely utilized in the empirical literature, is to linearly approximate the price index [32]:

$$\ln P = \sum_k w_k \ln p_k$$

whereas k denotes a set of co-variables at the household and cluster level, in our case, the age, sex and educational level of the head of household and the number of household members, and u_{ihct} represents the error term at the level of the household i .

Additionally, this system of equations will be estimated for different groups of households according to family per capita income terciles, with the intention of identifying different own price and income elasticity for the demand of non-alcoholic beverages. The first tercile corresponds to 40 percent of households with the lowest family per capita income (quintiles 1 and 2); the second tercile corresponds to the next 40% of households (quintiles 3 and 4) and the last tercile corresponds to the 20% of households with the highest family per capita income (fifth quintile).

2.3. Variables

We define three different categories of non-alcoholic beverages which consumption can be complementary or substitute: 1) Sodas, 2) Flavored waters and juices (flavored waters, fresh juices, concentrated juices and powdered juices) and 3) Mineral water (plain mineral water and carbonated mineral water). The expenditure share in each category was estimated by averaging the expenditure in each category divided by the overall total expenditures.

The average implied prices per liter of beverage categories were estimated by dividing each beverage's expense by the number of quantities purchased. When the quantities of a product were not expressed in liters of ready-to-drink beverage (the case of powdered juices or concentrated juices), they were converted to liters of ready-to-drink beverage. An outlier of implicit price per type of beverage is detected when it exceeds the average implicit price of its category +/- two standard deviations (2 SD) and is replaced by the average implicit price of the beverage +/- 2 SD. [22,25]. The implicit prices were deflated using the Consumer Price Index, with 2013 being the base year [33].

Similar to other studies in the region [22,24,25], the econometric specifications control for age, sex and educational level of the head of the household (at least complete secondary education), and the number of household members. All estimates were stratified by quintile of family per capita income based on the ENGHo 2012/2013.

2.4. Simulation of tax scenarios

A simulation analysis of scenarios considering potential price increases of SSB via tax changes involves identifying the particular taxation scheme in the country, which governs the chain of production and sale at the local level, characterized by a multiplicity of national, provincial and local taxes [34]. Regarding sugar-sweetened beverages, Internal Taxes Law No. 25,239 enacted in 1999 establishes an aliquot of 8% for sodas and 4% for beverages that use fruit juices for sweetening [35].

In addition, it is necessary to consider the potential increase of the country's per capita gross product in the short term (as a proxy of family income). This could lead to an increase in the consumption of SSB that could eventually compensate the advances achieved through a tax increase. According to estimations of the International Monetary Fund [36], the national gross product of Argentina should have increased by 2.7% in 2017 in relation to 2016, reaching 3.1% by 2020.

In the research simulation exercise, three hypothetical scenarios of price increases via taxes were defined, at 10%, 25% and 50%. The effects of these price increases on the quantities consumed per type of beverage were simulated from the estimated price elasticities of demand. Likewise, the effect of the expected increase in family income -represented by the expected growth of the economy in 2017- on the quantities consumed by type of beverage was simulated based on the estimate of income elasticity of demand.

3. Results

Table 1 shows descriptive information for households covered by the ENGHo 2004/2005 and 2012/2013. There is a small reduction in the average age of the head of household, a decrease in the percentage of male heads of family, and a significant increase in the percentage of household heads with at least a complete secondary education among periods. In addition, surveys show that the average number of household members who are fourteen years old or younger decreases between 2004/2005 and 2012/2013, confirming the demographical transition taking place in the country [37]. On the other hand, the indicator of spending on food and beverages over total household expenditures remains practically unchanged between the two surveys (39.38% vs. 38.45%), while the disbursements on non-alcoholic beverages over total expenditure on food and beverages shows a slight increase during the period analyzed (7.97% to 8.72%).

Table 1. Socio-economic characteristics of Argentine households based on the National Household Expenditure Surveys (ENGHo) 2004/2005 and 2012/2013.

Variable	2004/2005	2012/2013
Age of the head of household (years old)	50.11	49.75
Male head of household (%)	70.63	65.13
Head of household with full secondary education and more (%)	37.13	46.82
Number of household members	3.42	3.23
Number of household members under the age of 14	0.9	0.82
Expenditure on food and beverages* / Total expenditure (%)	39.38	38.45
Expenditure on non-alcoholic beverages / Expenditure on food and beverages (%)	7.97	8.72

Notes: *It includes the following categories: 1) Bakery products, 2) Flours, rice, noodles and pasta, 3) Fresh meats, 4) Cold cuts and sausages, 5) Fish and seafood, 6) Oils and fats, 7) Milk, 8) Dairy products, 9) Eggs, 10) Fruits, 11) Vegetables and legumes, 12) Sugar, sweets and cocoa, 13) Coffee, tea and mate, 14) Sauces and condiments, 15) Food prepared and ready to eat, 16) Non-alcoholic beverages, 17) Alcoholic beverages, and 18) Food and drinks outside the home.

Table 2. Consumption of non-alcoholic beverages by Argentine households based on the National Household Expenditure Survey (ENGHo) 2004/2005 and 2012/2013.

	2004/2005	2012/2013
Percentage of households with expenditure on beverages > 0		
Sodas	60.62	57.20
Flavored waters	0.84	9.15
Fresh juices	7.19	11.14
Concentrated juices	10.84	4.60
Powdered juices	17.90	35.82
Mineral water	11.27	15.91
Carbonated Mineral water	8.91	7.74
Average amount of liters purchased*		
Sodas	26.16	24.27
Flavored waters	12.22	12.66
Fresh juices	6.04	6.21
Concentrated juices	56.97	55.52
Powdered juices	23.84	17.42
Mineral water	21.69	32.64
Carbonated Mineral water	21.11	19.60
Average implied prices per liter**		
Sodas	3.75	6.11
Flavored waters	5.65	6.49
Fresh juices	8.00	10.27
Concentrated juices	0.81	0.97
Powdered juices	1.50	2.91
Mineral water	3.42	4.75
Carbonated Mineral water	2.33	3.40

Notes: * Estimated on a monthly basis. ** Expressed in 2013 Argentinean pesos.

Table 3 shows the results of the estimates of own price, cross price and income elasticity for the following categories: 1) Sodas, 2) Flavored waters and juices, and 3) Mineral water and Carbonated Mineral Water. Own price elasticity for sodas is -1.14, which implies that with a 10% price increase, quantities demanded are reduced by 11.4%, a more than proportional change. On the other hand, the income elasticity of the demand for sodas is 0.99, which implies that in the face of a 10% increase in family income, the quantity demanded of sodas increases by 9.9%. Similar interpretations can be made for the case of flavored waters and juices and mineral water. Estimates of the cross-price elasticity of each category of beverages relative to sodas suggest

that there is a slight pattern of substitution between products. When the price of sodas increases by 10%, the quantities of flavored waters and juices rise by 1% and those of mineral water and carbonated mineral water by 1.8%. Figures 1 and 2 suggest that there are no significant differences in the own price and income elasticity by type of beverage according to the household income tercile.

Table 4 shows the results of the simulation of the price increase of SSB via taxes on the average quantities purchased at the household level. It is observed that advancing a tax strategy that increases the prices of beverages with sugar by 50% leads to a more than proportional reduction in the amounts purchased by households, which could lead to significant health improvements in the short and the long term.

Table 3. Own price, cross price and income elasticity of the demand for non-alcoholic beverages.

Category	Own price elasticity	Cross price elasticity with Sodas	Income elasticity
Sodas	-1.14	-	0.99
Flavored waters and juices	-1.11	0.10	0.95
Mineral water and Carbonated Mineral water	-1.23	0.18	1.08

Figure 1. Own price elasticity of the demand for non-alcoholic beverages per quintile of family per capita income.

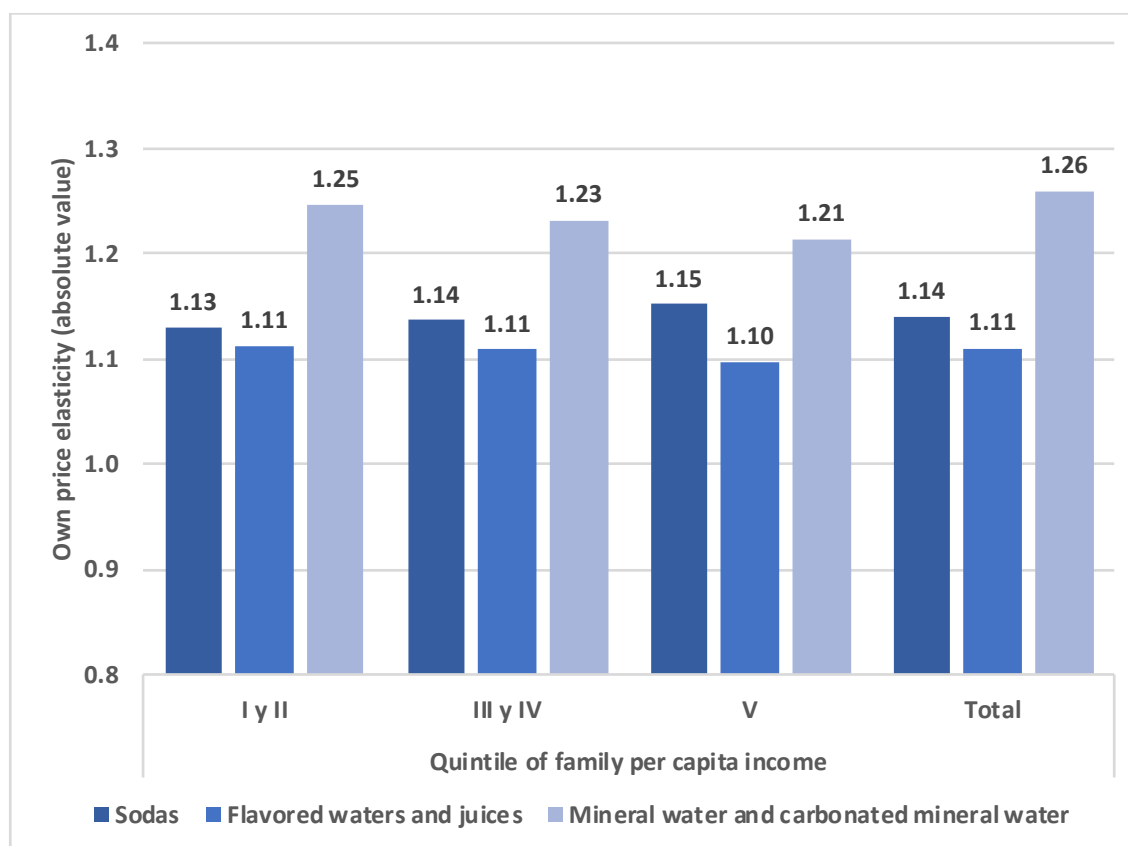


Figure 2. Income price elasticity of the demand for non-alcoholic beverages per quintile of family per capita income.

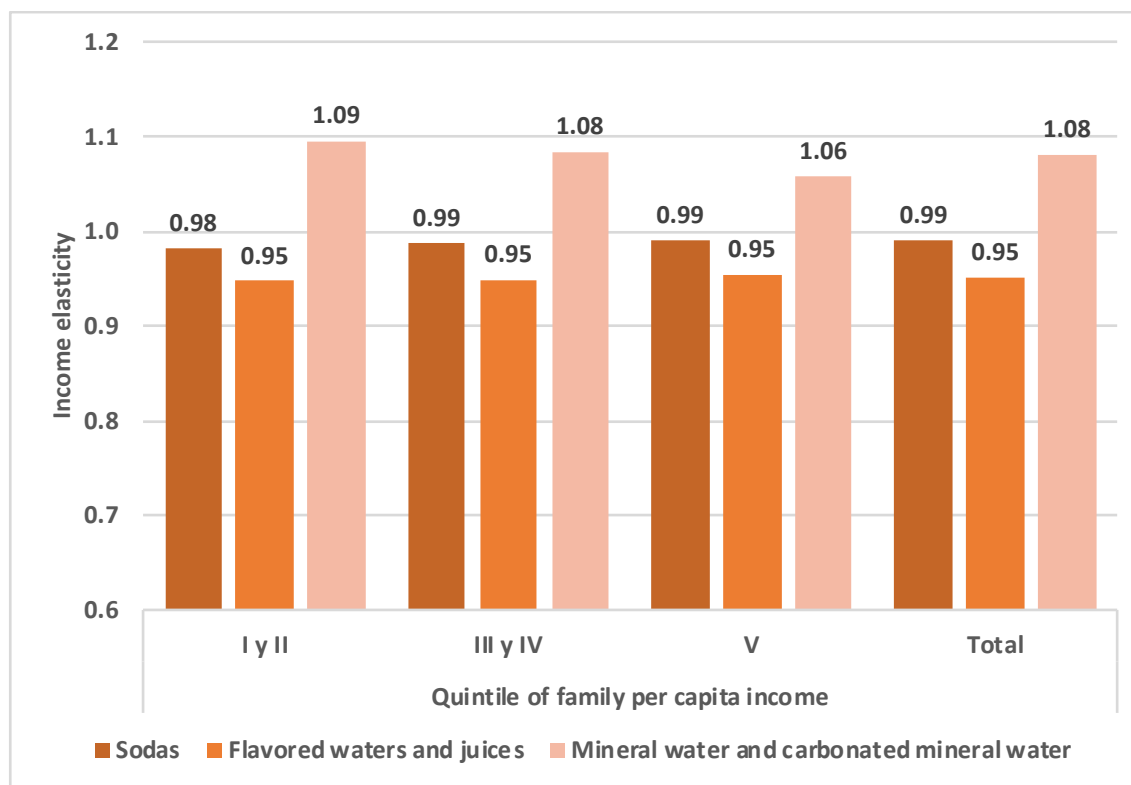


Table 4. Simulation of scenarios: effect of the increase in the prices of beverages of 10%, 25% and 50% through taxes on the acquired quantities (liters).

Beverage	Acquired quantities	% Increase in prices through taxes					
		10%		25%		50%	
		Absolute diff.	Relative diff.	Absolute diff.	Relative diff.	Absolute diff.	Relative diff.
Sodas	24.3	-2.12	-8.73%	-6.27	-25.83%	-13.19	-54.33%
Flavored waters	12.6	-1.08	-8.54%	-3.18	-25.19%	-6.68	-52.94%
Fresh juices	6.2	-0.53	-8.54%	-1.56	-25.19%	-3.29	-52.94%
Concentrated juices	55.5	-4.74	-8.54%	-13.98	-25.19%	-29.39	-52.94%
Powdered juices	17.4	-1.49	-8.54%	-4.38	-25.19%	-9.22	-52.94%

4. Discussion

We found that the own price elasticity of sodas in Argentina is -1.14, which implies that with a price increase of 10% of such type of beverage, its quantity demanded is reduced by 11.4%, which is a more than proportional change. Similarly, the income elasticity of the demand for sodas is 0.99, which implies that in the face of a 10%

increase in family income, the quantity demanded by sodas increases by 9.9%. Our findings are similar to those presented by the international literature, particularly to the studies conducted in the region, where household expenditure surveys are used as main sources of information [22,24,25].

A simple simulation exercise suggests that, due to the high level of consumption of SSB in Argentina and the current state of the tax policy in the country, it is pertinent to move forward with a strong tax scheme on these types of beverages. Particularly, advancing a 50% price increase via taxes could lead to a more than proportional reduction of the amounts purchased of these beverages at the household level, which could furthermore lead to significant health improvements in the short and long term.

The simulation exercise assumes that the tax is passed on to prices in full (pass-through equal to one), although it will depend on producer companies' reactions to the eventual new fiscal policy. While this assumption may seem reasonable, there are market structures that might not reflect these results. For example, Grogger [38] identifies that in the case of Mexico, the 2014 tax increases were transferred more than proportionally to prices, which is a behavior that is compatible with highly concentrated markets [39]. If this concentrated market structure occurs in Argentina, the estimated values in the simulation exercise could constitute a lower band in the estimation of the reduction of consumption of soft drinks. However, more research at the local level is necessary, not only in terms of potential tax scenarios, but also in the understanding SSB market characteristics.

The study performed by Maceira [40] proposes an analysis of SSB supply chain to identify the necessary changes in the Argentinean soft drink market to create a healthier food environment. They found that there is a high level of market concentration, great diversification in products, the emergence of second brands and own (hipermarkets') brands, as well as a shift of consumption towards relatively healthier beverages.

The study has several limitations. First, the household expenditure survey does not identify the consumption of beverages in restaurants and bars. Although it is not necessarily accurate to suppose that own price, cross-price and income elasticity of the demand will be similar outside of the the family environment, a large part of the expenditure on food and beverages occurs within the home (almost 90% according to ENGHo 2012/2013). Second, not all possible beverages with added sugar have been considered in the analysis, such as tea, coffee, milk, etc. Due to the fact that added sugar is not identical across household members, it was decided to exclude them from the analysis. Third, although in the study included the consumption of sugar-free beverages, such as mineral water and carbonated mineral water, it was not possible to incorporate the consumption of tap water from the public supply network. Quality of drinking water is quite high in many locations in Argentina (the percentage of the population with access to drinking water is 83%, [41]), therefore it is reasonable to argue that tax increases on SSB may lead to more reliance on the water system. Finally, information about clusters by neighborhood were not available to perform this study. Instead estimations use provincial levels as control variables. Nevertheless, second brands are relatively non-significant in the SSB

market, where main producers heavily concentrate local sales, reducing potential distortions associated with differences in qualities and tastes [40].

Despite these limitations, the article introduces evidence that an increase in the prices of sugar-sweetened beverages via taxes leads to a considerable reduction in their consumption in Argentina. As a conclusion, a robust tax policy on sugar-sweetened beverages may act -considering price elasticity issues and potential within-the-firm cross subsidies - as a tool within a strategy to achieve public health objectives in this matter.

5. Conclusions

Estimates of price and income elasticity of demand for SSB are relevant for the design of an effective fiscal policy with public health objectives. The evidence presented in this study suggests that the demand for SSB is elastic in Argentina, and therefore a policy of increasing prices through taxes would have a significant effect on the quantities demanded. Particularly, an increase of 10% in the price of sodas should lead to a reduction of 11.4% in the liters consumed, while a 10% increase in household income would lead to an increase of 9.9% in the quantities consumed. However, these results depend on the structure of the local SSB market and the mechanisms for passing taxes to prices.

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