# THE IMPACT OF BEVERAGE TAXES ON QUANTITY AND QUALITY OF CONSUMPTION IN FRANCE

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Abstract

Many countries around the World have applied, or are studying to apply, sugar-sweetened beverage taxes as a way to mitigate increasing obesity. The objective of our study is to illustrate about the relevance of controlling for quality choices *within* product categories when analyzing the impact of a sugar-sweetened beverage tax. We calculate own-price quantity and quality elasticities using the methodology developed by Deaton (1988). For comparison purposes, we also calculate own price elasticities with a standard unit price methodology, which means using unit values as a proxy for prices. With both set of elasticities, we simulate a scenario of 20% tax. Using Deaton's methodology, we find a decrease in quantity (-12.4%) and quality demanded (-0.3%). Using unit values methodology, we find a larger expected decrease in quantity demanded (-22.9%). Therefore, we show empirical evidence that both quantity and quality need to be taken into account to understand the implications of a sugar-sweetened beverage tax.

Keywords: beverage tax, unit value bias, quality

# 1. Introduction

Governments have considered or implemented various public policies to curb the increasing prevalence of obesity: food labeling regulations to provide easy-to-understand nutritional information about food products; informational campaigns, such as the five-a-day campaign, to increase consumer awareness about the benefits of healthy food; and food taxes based on nutritional quality to increase the relative prices of products high in fat, salt, and/or sugar and provide monetary incentives (subsidies) in favor of healthier food choices.

Specifically, our study focuses on the impact of sugar-sweetened beverage (SSB) taxes, which have been increasingly considered as a way to improve the overall health of the population (Finkelstein, *et al.*, 2013). However, a SSB tax may cause consumers to reallocate expenditure to other non-taxed beverages, which is known as the substitution effect. For this reason, distinguishing the substitution pattern among beverages is crucial for predicting the actual impact a beverage tax (Block and Willett, 2011). For policy analysis, Smith, *et al*. (2010), Dharmasena and Capps (2011) and Zhen *et al.* (2011) emphasize the relevance of taking own-price, as well as cross-price elasticities, hence taking the substitutability and complementarity effects among beverage groups into account.

Yet, following a SSB tax, people may adjust both, their quantity and quality of purchases. People may decrease their overall consumption of SSB, but also they may switch to different SSB of varying quality (e.g. generic labels instead of national brands). This substitution effect may neutralize the impact of the tax on sugar consumption, or even have negative health effects if the consumption of alcohol or other unintended beverages rise. As a result, all substitution effects, both between and *within* beverage categories, must be taken into account in the empirical analyses of such tax effects.

The objective of our study is to illustrate the relevance of controlling for quality choices *within* product categories when analyzing the impact of a SSB tax[1]. We compare the methodology developed by Deaton (1988) and a standard unit value methodology. The methodology by Deaton (1988) distinguishes between quantity and quality responses, while the standard unit value methodology does not. Unlike previous studies in SSB taxes, we calculate own price own price quantity and quality elasticities. Finally, taking into

[1] It is not our objective to fully measure the impact of a SSB at this stage. If that were the case, we are aware that we would need to take other elements into account, such as cross price effects and market structure.

consideration that Dharmasena and Capps (2011) and Smith *et al.* (2010) simulated the impact of 20% SSB tax rate, we use the same rate to simulate the impact on quality and quantity demanded.

We work with beverages because this sector has generated controversy in the public health policy arena (Vartanian, *et al.*, 2007). According to Brownell and Frieden (2009), the consumption of SSB has been criticized as one of the most relevant drivers of obesity in the United States (US). Vartanian, *et al.* (2007), after reviewing eighty-eight studies, indicated a clear and consistent link between SSB consumption and increased calorie intake. In France, as presented by Bonnet and Requillart (2011), on average, *per capita* soft drink consumption has been lower than that of the European average. Nevertheless, from 1994 to 2004, on average, soft drink consumption increased by 32% (Bonnet and Requillart, 2011).

The remainder of this paper is organized as follows: section 2 briefly discusses some concerns on beverage tax analysis, section 3 presents Deaton's methodology to calculate elasticities and describes the data, section 4 presents and discusses the empirical results, and finally, section 5 summarizes our findings and highlight some future research.

## 2. Studies on Sweetened Beverage Taxes

The final impact of a SSB tax is ambiguous. On one hand, SSB tax leads to a reduction on the own quantity demanded (Dharmasena and Capps, 2011, Smith, *et al.*, 2010, Zhen, *et al.*, 2011). The tax may have a threshold to be effective. Mytton, *et al*. (2012) stated that any food tax would need to be at least 20% to have a significant effect on health. Smith, *et al*. (2010) estimated that a 20% tax on caloric beverages leads to a decrease of 25.28% on SSB. Assuming the same tax rate, Dharmasena and Capps (2011) estimated a reduction on quantity demanded between 14% and 77% depending on the type of SSB. Therefore, empirical evidence supports the idea that an SSB tax would lead to a reduction on SSB quantity demanded.

On the other hand, if we want to measure the full impact of a SSB tax, we also need to take into account the impact on other beverages and non-beverage groups. Fletcher, *et al.* (2010) found that, in children and adolescents, a SSB tax would lead to a caloric reduction that is completely offset by increases in calories from other beverages. As unintended consequences, Dharmasena and Capps (2011) showed that an SSB tax would increase the demand for low-fat milk, fruit juices and coffee. Finkelstein, *et al*. (2013) went a step further by taking into account the substitution with non-beverage items. However, the authors did not find significant evidence of substitution into non-beverage food groups.

Consequently, most of the SSB tax studies have focused on the direct impact (expressed by the own-price elasticity), and on the indirect impact on other beverage groups (expressed by the cross-price elasticities) using a demand systems approach. However, very little attention has been given to the quality effects. Notable exceptions are the studies by Bonnet and Réquillart (2012) and Allais *et al*. (2012), which have concentrated on the quality effects of the tax using an empirical industrial organization approach.

Finally, SSB tax analysis is affected by the available data. In the absence of product prices, a common practice in demand analysis is to use unit values as a proxy for prices. Unit values are calculated by dividing total expenditure by total quantity sold. However, Deaton (1988) and McKelvey (2011), among others, have showed that unit values do not always provide an appropriate proxy for prices. When making purchase decisions, consumers not only consider product quality but quantity as well. Generally, higher quality products are associated with higher selling prices. As a consequence, unit values contain price and quality information of consumer choices (Deaton, 1988). A change in unit value may reflect a change in product quality or a change in product price. In the next section, we present the methodology developed by Deaton (1988), which would allow us to calculate quantity and quality own-price elasticities to disentangle both effects after the application of an SSB tax.

# 3. Methodology

### 3.1. Analytical Framework

In this section, we summarizes the methodology by Deaton (1988). We complement with explanations provided by McKelvey (2011) with respect to framework developed by Deaton (1988). Assuming weak separability between different types of groups, Deaton (1988) developed a two-stage methodology to adjust for unit values, in which he derived separate expressions for quantity and quality elasticities. The expenditure of group *c*, $E_c$ can be broken down into price ($p_c$) and quantity ($q_c$) vectors:

$$E_c = p_c q_c$$

in which, $p_c = \lambda_c p_c^*$, and $p_c^*$ is a vector of relative prices of commodities *within* the group, and it is unobservable when only unit value data is available. $\lambda_c$ is a scalar which takes into account common price component for all commodities of the group and can be calculated using a price index. Since $p_c^*$ is unobservable, Deaton (1988) assumes that variations of $p_c$ are mainly due to $\lambda_c$. Therefore, $E_c$ becomes:

$$E_c = \lambda_c p_c^* q_c = \lambda_c \frac{p_c^* q_c}{Q_c} Q_c = \lambda_c v_c Q_c \qquad \textbf{(1)}$$

in which, $Q_c$ is the total group consumption. Using equation **(1)**, unit value, $V_c$, is expressed as:

$$V_c = \frac{E_c}{Q_c} = \lambda_c v_c \qquad \textbf{(2)}$$

applying the natural logarithm to both sides,

$$lnV_c = ln\lambda_c + lnv_c \qquad \textbf{(3)}$$

Meaning that the logarithm of the unit value of group $c$ corresponds to the sum of logarithm of price and quality. This expression shows that unit values are simultaneously a measure of price and quality. Consequently, as expressed by McKelvey (2011) to understand the relationship between quantity demanded and unit value, we also need to understand the relationship between price and quality, which is expressed as:

$$\varepsilon_p = \frac{\partial lnQ_c}{\partial ln\lambda_c} = \frac{\partial lnQ_c}{\partial lnV_c} \cdot \frac{\partial lnV_c}{\partial ln\lambda_c} = \frac{\partial lnQ_c}{\partial lnV_c}\left(1 + \frac{\partial lnv_c}{\partial ln\lambda_c}\right) \qquad \textbf{(4)}$$

in which $\varepsilon_p$, $\partial lnQ_c/\partial ln\lambda_c$, is the price elasticity of group $c$ with respect to price $\lambda_c$. The last step in equation **(4)** is a substitution using the partial derivative with respect to $\lambda_c$ in equation **(3)**. Using unit values as a proxy for price is equivalent to assuming that $\partial lnv_c/\partial ln\lambda_c = 0$. In contrast, assuming that $\partial lnv_c/\partial ln\lambda_c$ is negative and less than one, the whole term between parentheses is less than one, thus, means that use of unit values as a proxy for price leads to an overestimation of the actual own price elasticity. After a price increase, people may partially cancel out the decrease in quantity demanded by reallocating expenditure *within* the group. From equation **(1)**, we know that $E_c = \lambda_c v_c Q_c$. Now, taking the natural logarithm and differentiating with respect to $\lambda_c$, Deaton (1988) derives the following expression:

$$\frac{\partial lnE_c}{\partial ln\lambda_c} = 1 + \frac{\partial lnv_c}{\partial ln\lambda_c} + \frac{\partial lnQ_c}{\partial ln\lambda_c} = 1 + \frac{\partial lnv_c}{\partial ln\lambda_c} + \varepsilon_p \qquad \textbf{(5)}$$

Moreover,

$$\frac{\partial ln v_c}{\partial ln \lambda_c} = \frac{\partial ln v_c}{\partial ln E_c}\left(\frac{\partial ln E_c}{\partial ln \lambda_c} - 1\right) \qquad \textbf{(6)}$$

Now, equation **(5)** provides an expression to substitute $\partial lnE_c/\partial ln\lambda_c$. Applying the natural logarithm and taking the partial derivative with respect to $E_c$ in equation **(3)**, it provides an expression to substitute $\partial lnv_c/\partial lnE_c$ under the assumption that ($\partial lnV_c/\partial lnx = \partial lnv_c/\partial lnx$). Therefore, equation **(6)** becomes:

$$\frac{\partial ln v_c}{\partial ln \lambda_c} = \frac{\frac{\partial ln v_c}{\partial ln X}\frac{\partial ln Q_c}{\partial ln \lambda_c}}{\frac{\partial ln Q_c}{\partial ln X}} \qquad \textbf{(7)}$$

Equation **(7)** gives us an expression for the quality elasticity, in which, the relationship between quality and price is explained based on income (or expenditure) elasticity with respect to quality, $\partial lnv_c\,/\partial lnX$, and quantity, $\partial lnQ_c\,/\partial lnX$, and the price elasticity of quantity, $\partial lnQ_c\,/\partial ln\lambda_c$. The term $\partial lnv_c\,/\partial lnX$ is expected to be positive, since as income increases quality demanded also increases. The term $\partial lnQ_c/\partial lnx$ is positive for a normal commodity. Finally, the term $\partial lnQ_c\,/\partial ln\lambda_c$ is negative, due to the law of demand. As a result, $\partial lnv_c\,/\partial ln\lambda_c$ is negative, which will be tested in the empirical section of this article. According to McKelvey (2011):

$$\frac{\partial ln Q_c}{\partial ln V_c} = \frac{\partial ln\frac{Q_c V_c}{x}}{\partial ln V_c} - 1 = \frac{\partial ln Q_c}{\partial ln V_c} + \frac{\partial ln V_c}{\partial ln V_c} - \frac{\partial ln X}{\partial ln V_c} - 1 = \frac{\partial ln w_c}{\partial ln V_c} - 1 = \frac{\frac{\partial ln w_c}{\partial ln V_c}}{w_c} - 1 \qquad \textbf{(8)}$$

in which, $w_c = Q_cV_c/X$ is the budget share for group $c$. Expression **(8)** assumes that $\partial lnX/\partial lnV_c = 0$. Using equation **(7)** to substitute for $\partial lnv_c/\partial ln\lambda_c$ and equation **(8)** to substitute for $\partial lnQ_c/\partial lnV_c$, equation **(4)** becomes:

$$\varepsilon_p = \frac{\partial ln Q_c}{\partial ln \lambda_c} = \frac{\partial ln Q_c}{\partial ln V_c}\left(1 + \frac{\partial ln v_c}{\partial ln \lambda_c}\right) = \left(\frac{\frac{\partial ln w_c}{\partial ln V_c}}{w_c} - 1\right)\left(1 + \frac{\frac{\partial ln v_c}{\partial ln X}\frac{\partial ln Q_c}{\partial ln \lambda_c}}{\frac{\partial ln Q_c}{\partial ln X}}\right) \qquad \textbf{(9)}$$

Isolating $\varepsilon_p$ ,

$$\varepsilon_p^{Deaton} = \frac{\left(\frac{\partial ln Q_c}{\partial ln X} + w_c\right)\left(\frac{\partial ln w_c}{\partial ln V_c} - w_c\right)}{\left(\frac{\partial ln Q_c}{\partial ln X} + w_c\right) - \frac{\partial ln Q_c}{\partial ln X}\left(\frac{\partial ln w_c}{\partial ln V_c} - w_c\right)} \qquad \textbf{(10)}$$

Finally, in the standard unit value method, $\partial lnv_c / \partial ln\lambda_c$= 0, thus equation **(9)** becomes:

$$\varepsilon_p^{Uvalue} = \frac{\partial lnQ_c}{\partial ln\lambda_c} = \left( \frac{\frac{\partial lnw_c}{\partial lnV_c}}{w_c} - 1 \right) \quad \textbf{(11)}$$

### 3.2. Data

We use the TNS-KantarWorldPanel home scanner dataset. We use a subsample that provides household data from January 2008 to December 2010 in France. Beverage expenditures are broken down into forty eight categories (e.g. sugar-sweetened sodas, artificially-sweetened sodas, sport drink, natural fruit juices, bottled waters, beers, cider, champagne and whisky). This dataset also has demographic information at the household level.

We aggregate the data into five groups of beverages: bottled water, natural juices, SSBs and artificially-sweetened beverages and alcoholic beverages. We try to use groups similar to those used in previous studies. However, this is not an easy task. Most of the previous studies have been conducted in the US, where children and adolescents commonly drink milk with meals and isotonic beverages are increasingly popular. In contrast, both behaviors are not commonly seen in France. In addition, French people commonly buy beverage syrups, which are a type of concentrated drink that people add water to before consuming. To the best of our knowledge, beverage syrups are not frequently purchased by US households.

Table 1 shows the annual basic statistics *per capita*, in which we divide the household expenditure by the number of people in the household. Some beverage series contain more data than others, since each household does not purchase from each type of beverage each year. In Table 1, column "n" shows the average annual number of households that have spent at least on a beverage of that group. The column "non-expenditure share" shows the proportion of households that have not spent on any beverage of that group.

A household can have numerous reasons beyond price to not spend on some beverages (e.g. taste, religion, and medical restrictions). If a household does not spend from a beverage group over a year, we assume that the household is not part of the market. Given our objective is to analyze a SSB tax, it is unlikely that a SSB tax variation would cause a response in this type of household. We do not treat them as true zero, instead, we consider that the household is not in the market. As a result, we do not work with censored data.

Under this assumption of treatment of non-expenditure option, Table 1 presents basic statistics about quantities and unit prices. The latter corresponds to the total expenditure of a group divided by the total quantity per year. With respect to quantity, per year, a person consumes twice as much water as natural juices and sweetened beverages (sugar and artificially sweetened) combined. In addition, SSBs are consumed three times more than artificially sweetened beverages. Water is less expensive than sweetened beverages (sugar and artificially sweetened), which are less expensive than natural fruit juices, and finally, alcoholic drinks.

Table 1: Basic Annual Statistics *per capita*

| **unit value (euro/liter)** | **n** | **mean** | **SD** | **min** | **max** |
|---|---|---|---|---|---|
| bottled water | 2,008 | 0.30 | 0.19 | 0.07 | 2.22 |
| natural fruit juices | 1,757 | 1.27 | 0.55 | 0.32 | 11.73 |
| sugar sweetened drinks | 2,030 | 1.05 | 0.58 | 0.12 | 10.12 |
| artifically sweetened drinks | 1,157 | 0.81 | 0.46 | 0.07 | 5.57 |
| alcoholic drinks | 2,058 | 4.06 | 2.64 | 0.50 | 42.45 |

| **quantity (liters/year)** | **non-expenditure share** | **mean** | **SD** | **min** | **max** |
|---|---|---|---|---|---|
| bottled water | 4% | 101.4 | 102.5 | 0.1 | 544.0 |
| natural fruit juices | 16% | 10.1 | 12.1 | 0.1 | 71.0 |
| sugar sweetened drinks | 3% | 28.2 | 30.6 | 0.2 | 223.2 |
| artifically sweetened drinks | 45% | 9.1 | 15.4 | 0.1 | 110.0 |
| alcoholic drinks | 2% | 39.6 | 50.5 | 0.1 | 332.5 |

The column "n" is the average number of households per year with expenditure in that beverage group. The column "non-expenditure share" is the proportion of households that do not spend in that beverage group. The following columns are the mean, standard deviation, minimum and maximum annual average expenditure, which consider only households that have spent in that beverage group. Households that do not spend in the whole year are not considered in the relevant market. 1 euro = 1.31 US Dollar (April, 29th 2013), 1 liter = 33.814 us fl oz

Finally, we create clusters per geographical regions and year. France can be divided into 9 regions administratively: metropolitan region (Île-de-France), Parisien basin (Basse-Normandie, Bourgogne, Centre, Champagne-Ardenne, Haute-Normandie, Picardie), North (Nord-Pas-de-Calais), East (Alsace, Franche-Comté, Lorraine), West (Bretagne, Pays de la Loire, Poitou-Charentes), South-West (Aquitaine, Limousin, Midi-Pyrénées), Center-East (Auvergne, Rhône-Alpes) and Mediterranean region (Corse, Languedoc-Roussillon, Provence-Alpes-Côte-d'Azur). By doing this, we conserve the panel structure of the dataset, keeping the household as a unit of analysis.

### 3.3. Estimation

Deaton (1988) recommended a two-step procedure. In the first step, $\partial lnv_c / \partial lnx$ and $\partial lnQ_c / \partial ln\lambda_c$ are estimated using ordinary least squares (OLS). It is assumed that (i) a change in total expenditure would affect unit value and quality proportionally, $\partial lnV_c / \partial lnX = \partial lnv_c / \partial lnX$, and that (ii) the expenditure elasticity can be expressed as $\partial lnQ_c / \partial lnX = (1/w_c)(\partial w_c / \partial lnX) - (\partial lnV_c / \partial lnX) + 1$:

$$w_{c,it} = \alpha_1 + \beta_1 lnx_{it} + \gamma_1 z_{it} + f_{mt} + u_{1c,it} \quad \textbf{(12)}$$

$$lnV_{c,it} = \alpha_2 + \beta_2 lnx_{it} + \gamma_2 z_{it} + u_{2c,it} \quad \textbf{(13)}$$

in which, $f_{mt}$ is the fixed effect for cluster $m$, and $z_{it}$ are the demographic variables. The fitted values from equations **(12)** and **(13)** are used to estimate equation **(14)**:

$$\widehat{w}_{c,mt} = \alpha_3 + \phi_3 ln\widehat{V}_{c,mt} + u_{3,mt} \quad \textbf{(14)}$$

Since quantity appears in the numerator of the dependent variable and the denominator of the explanatory variable, a measurement error in quantity would lead to spurious correlation between $w_c$ and $V_c$. To compensate for bias in this potential measurement error, rather than using OLS in equation **(14)**, Deaton (1988) proposed to use within cluster variation in the budget share and unit value. Therefore, $\partial w_c / \partial lnV_c$ corresponds to:

$$\widehat{\phi}_3 = \frac{cov(\widehat{w}_{c,mt}, ln\widehat{V}_{c,mt}) - \widehat{\sigma}_{12}/\tau}{var(ln\widehat{V}_{c,mt}) - \widehat{\sigma}_{22}/\tau^{+}} \quad \textbf{(15)}$$

In which $\widehat{\sigma}_{12}$ is the correlation between the first stage error terms $u_1$ (from equation **(12)**) and $u_2$ (from equation **(13)**), and $\widehat{\sigma}_{22}$ is the variation of the $u_2$. The average number of households per cluster is $\tau$, and the average number of households with positive consumption is $\tau^{+}$. Since each equation is estimated separately, we are able to work with different sample size in each beverage group. Finally, using equations **(7)** and **(10)**, we calculate the quality and quantity elasticities presented by Deaton (1988). For comparison purposes, using equation **(11)**, we calculate own price elasticities using a standard unit value procedure. In this case, budget shares are explained by the natural logarithm of total beverage expenditure, demographic characteristics and natural logarithm of unit values as presented by McKelvey (2011).[2] With these estimated elasticities, we present a policy scenario that assumes a 20% tax on SSB.

## 4. Results and Discussion

Considering that the objective of our study is to illustrate about the relevance of controlling for quality choices *within* product categories when analyzing the impact of an SSB tax, Table 2 presents own price elasticity for SSB using Deaton's methodology and the standard unit value methodology. Deaton's methodology allows us to distinguish between quantity and quality elasticities. In contrast, the standard unit value methodology does not allow us to make this distinction, thus, these own price elasticity combines both effects. Using the SSB own price elasticity, we estimate the impact of a 20% SSB tax for each methodology. For reference purposes, we also present the own price elasticities for other beverages.

According to Deaton's empirical framework, own price quality elasticity should be negative. As expected, we found that the expression $\partial ln v_c / \partial ln \lambda_c$ is negative. Moreover, due to the law of the demand, own price quantity elasticity also should be negative. As expected again, we also found that the expression $\partial ln Q_c / \partial ln \lambda_c$ is negative.

From equation **(4)**, we expect that use of unit values as a proxy for price leads to an overestimation of the actual own price elasticity. Table 2 shows that, the standard unit value methodology leads to a larger elasticity (in absolute terms) compare to Deaton's methodology. SSB has an own quantity elasticity of -0.62 using Deaton's methodology and -1.14 using the standard unit value methodology.

Own price quantity elasticities have a magnitude greater many times that of own price quality elasticities, which is consistent with the work presented by McKelvey (2011). Thus, after a price change, households on average adjust their purchased SSB quantity more than their SSB quality. Moreover, we consider elasticity estimation as an upper limit since we are not taking into account substitution between beverage groups. After applying a SSB, it is likely that households reallocate consumption to other types of beverages.

[2] Since Deaton's methodology uses a fixed effect model to explain budget shares, for robustness purposes of the standard unit value methodology, we repeat the estimation using fixed effect models with similar results to those presented in Table 2.

Using Deaton's methodology, our study finds that SSB own price quantity elasticity is -0.62. Using the standard unit value methodology, we estimate that SSB own price elasticity is -1.14. Smith, *et al*. (2010) calculated a SSB own price elasticity of -1.26. Finkelstein, *et al*. (2010) estimated a SSB own price elasticity of -0.89. As previously mentioned, the difference in the group definition makes it difficult to compare studies. In this sense, Dharmasena and Capps (2011) found that own price elasticity can vary by as much as five to six times depending on the type of SSB.

With respect to the hypothetical scenarios, Dharmasena and Capps (2011) and Smith, *et al*. (2010) assume a 20% tax on SSB. Dharmasena and Capps (2011) estimated a reduction on quantity demanded between 14% and 77% depending on the type of SSB. Smith, *et al*. (2010) reported a decrease of 25.28% on SSB. Assuming the same 20% beverage tax rate in the Deaton's methodology, we expect that quantity demanded of SSB would decrease by 12.4% and quality demanded would decrease by 0.3%. Using the standard unit value methodology, we expect that quantity demanded of SSB would decrease by 22.9%. Our estimation seems to be in the range of previous studies. However, once again, we want to be careful with comparison across countries (especially with respect to group aggregation as we discussed before). Moreover, Smith, *et al*. (2010) and Dharmasena and Capps (2011) use a demand system, while we estimated equations separately.

Table 2: Own Price Elasticities

| | Deaton's Methodology | | Unit Value Methodology | | Deaton's Methodology | Unit Value Methodology |
|---|---|---|---|---|---|---|
| | Own price quantity elasticity | | Own price quantity elasticity | | 20% beverage tax | |
| | Parameter | SD | Parameter | SD | Quantity Impact | Quantity Impact |
| bottled water | -0.23 | 0.002 | -1.02 | 0.03 | | |
| natural fruit juices | -0.21 | 0.002 | -0.60 | 0.04 | | |
| sugar sweetened drinks | -0.62 | 0.01 | -1.14 | 0.02 | -12.35% | -22.85% |
| artifically sweetened drinks | -0.14 | 0.0003 | -0.83 | 0.04 | | |
| alcoholic drinks | -0.06 | 0.00004 | -0.99 | 0.01 | | |
| | Own price quality elasticity | | | | | |
| | Parameter | SD | | | Quality Impact | |
| bottled water | -0.01 | 0.001 | | | | |
| natural fruit juices | -0.004 | 0.001 | | | | |
| sugar sweetened drinks | -0.02 | 0.003 | | | -0.33% | |
| artifically sweetened drinks | -0.005 | 0.0001 | | | | |
| alcoholic drinks | -0.005 | 0.0004 | | | | |

Elasticities are significantly different from zero at the 5% level. We also control for demographics: age of the reference person, occupation, people per household and type of household (rural or urban). Policy impact is calculated as a linear approximation.

# 5. Final Considerations

The objective of our study is to illustrate about the relevance of controlling for quality choices *within* product categories when analyzing the impact of a SSB tax. We used the methodology by Deaton (1988) to calculate own price quantity and quality elasticities for SSB. For comparison purposes, we also estimate own price elasticities using a standard unit value methodology as presented by McKelvey (2011). As predicted by Deaton' analytical framework, we showed that the use of unit values as a proxy for prices leads to an overestimation of own-price elasticities. Moreover, Deaton's methodology and the standard unit value methodology conduct to different predictions with respect to a SSB tax. For instance, assuming the same 20% beverage tax rate in the Deaton's methodology, we expect that quantity demanded of SSB would decrease by 12.4% and quality demanded would decrease by 0.3%. Using the standard unit value methodology, we expect that quantity demanded of SSB would decrease by 22.9%. Therefore, we show empirical evidence that both quantity and quality need to be taken into account to understand the implications of a SSB tax.

French market offers an interesting research opportunity to study the impact of beverage taxes, and we can therefore make a contribution to the policy debate. In January 2012, France implemented a beverage tax of 0.073 euros per liter to sugar-added and artificially sweetened soft drinks. France is the first country that applied a beverage tax to both types of soft drinks. At first, it may seem out of place to tax artificially sweetened soft drinks. However, Lutsey, *et al*. (2008) found that the consumption of artificially sweetened soft drinks is associated with higher instance of metabolic syndrome.

In the coming year, when data on purchases in 2012 are available, we will be able to compare the simulated impacts of the beverage tax presented in this study to the actual impacts. In this way, we will calibrate our *ex-ante* policy models and make policy recommendations on the relevance of taxing artificially sweetened beverages. In addition, after including cross price effects, we would be able to estimate substitution between and *within* beverages, including alcohol beverages. In this way, we will be able to estimate the impact of SSB tax on other beverage, including alcohol beverages.

Finally, we show empirical evidence that both quantity and quality need to be taken into account to understand the implications of a SSB tax. Other factors also enter into play, such as the market structure. Empirical evidence shows that beverage tax is not immediately fully transferable to consumer prices

(Berardi, *et al.*, 2012). Degree of competition, type of outlet and type of brand (national or generic brand) are some of factors that affect the speed with which a beverage tax is transmitted into a consumer price. Taking the market structure into account, as well as substitution patterns, will provide a more complete understanding of the ultimate impact of a SSB tax.

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