



Taxation of unhealthy consumption of food and drinks: An updated literature review*

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Summary

By means of a literature review this paper aims at shedding more light on the potentialities of unhealthy food/drink taxation in changing eating patterns and life styles and hence combating the obesity epidemic. One remarkable point that emerges when assessing the set of selected papers is the existence of a wide diversity of objectives, methodologies, settings and datasets, policies implemented and results achieved by all these studies, which undoubtedly adds complexity to any attempt to draw a general conclusion on fast food taxation. Most of the examined studies predict a rather modest fiscal impact on unhealthy food and drinks consumption and/or nutrition intake and consequently a poor result on weight loss and obesity, by the interplay of several factors among them the effects of cross-price elasticities.

Keywords: Unhealthy food taxation, Fast food, Caloric drinks, Obesity.

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1. Introduction

Obesity –a complex and multi-factorial chronic disease involving genetic, perinatal and environmental components– is an issue of primary public health concern in many developed

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countries. Excess weight is associated with an increased incidence of a range of chronic illnesses (including, cardiovascular disease, hypertension, type 2 diabetes mellitus, stroke, cholesterol, stroke, gallbladder disease, biliary calculus, narcolepsy, osteoarthritis, asthma, apnoea, gout and certain cancers) that tend to reduce the quality of life and ultimately result in death (Must *et al.*, 1999). Additionally, a significant number of obese patients tend to suffer mental disorders and social rejection leading to a loss of self-esteem, a particularly sensitive issue in the case of children (Allison *et al.*, 2009; Garipey *et al.*, 2010). The latest estimates in EU countries indicate that overweight affects between 30-70% and obesity affects 10-30% of adults. According to EASO (European Association for the Study of Obesity) data the prevalence of overweight (including obesity) in schoolchildren vary between 16-22% in the EU25, of which the obesity rate is 4-6%. The rise in child overweight has been particularly strong in most recent years. The worldwide prevalence of the condition nearly doubled between 1990 and 2008.

There exists a wide array of policies to tackle the obesity epidemic. Whereas some are based on non-economic incentives others rest on the economic rationality of consumers and suppliers. Among the former we find interventions seeking to provide better nutritional information to consumers to help them to make more informed decisions (for instance via mass media campaigns to raise awareness on health risks); actions to incentive participation in school nutrition programs intended to reinforce or develop a healthy eating or to change unhealthy food habits within households (e.g., the School Breakfast Program and the National School Lunch Program in the US where meals must meet federal nutritional requirements); the establishment of limits on certain categories of foods and on some form of availability (e.g., banning soda machines and vending machines containing unhealthy snacks at schools) or the regulation of food advertisement targeted to children; the promotion of physical exertion specially among children population at schools, parks or sportive clubs. Regarding the economic based interventions, one could even distinguish between positive monetary policies like financial aids, subsidies or tax exemptions to healthy food and food services production, and negative monetary policies like taxes on unhealthy food/drinks and food services production.

This paper is concerned with the later type of fiscal action. We aim at shedding more light on the potentialities of food taxation in changing eating patterns and hence combating obesity and overweight. Through a literature review, this paper analyses the objectives, policy designs implemented and main results achieved by a set of studies retrieved with the aim to extract some valid general policy recommendations. Two kinds of targets are disentangled from the reviewed studies: unhealthy food and sugar sweetened beverages (SSBs).

The paper is structured as follows. Section 2 briefly presents some arguments put in place by the literature to justify the taxation of unhealthy food, while Section 3 describes the procedure used to extract the papers assessed and analyses their main contributions. Section 4 concludes with some policy recommendations.

2. Should we tax unhealthy consumption? A controversy

There is not a general agreement among economists about using fast food taxes to reduce the obesity epidemic. Advocates of taxation point out several arguments which justify government intervention to correct certain market failures. First, technological change in agriculture has lowered the cost of eating calories with a consequent increase in the intake of energy dense food and drinks (Philipson and Posner, 1999). An inverse relationship between fast-food prices and body mass index (BMI) for both adults and teenagers has been actually verified (Chou, Grossman and Saffer, 2004; Powell 2009). Similarly, about 40% of the increase of weight over the last decades in the US was found to be due to the expansion in the supply of food via agriculture innovations that lowered food prices (Lakdawalla and Philipson, 2002). Hence, taxing food items rich in calories, saturated fat or sugar should then raise the prices of such foods relative to prices of healthier food and discourage the intake of the former products¹.

Second, due to the importance of the obesity-related diseases obese population tend to cause a negative externality on the non-obese in the form of higher utilization of healthcare resources and associated costs (Cawley, 2011; Mora, Gil and Sicras-Mainar, 2014). Although some costs are internalised by the obese employees (lower wages or labour market discrimination) other costs are externalised in the form of extra taxes or insurance premiums, since the latter are not based on obesity status². Not to mention other more indirect effects as higher labour absenteeism, work inefficiency, lower productivity affecting firms' profitability³. Proponents of the tax argue that would help individuals to make more informed lifestyle decisions contributing to reduce the size of the externality. Notwithstanding, opponents to such measures argue that most costs are, however, internalized since obese individuals tend to die earlier than healthy-weight individuals, claim less pension benefits and receive lower retirement income from the Social Security system (i.e., shorter labour careers and lower wages)⁴. Some even argue that there would be little reason to tax all consumers of sodas and fast foods who do not become obese, and whose consumption do not cause any social (external) costs (Posner, 2009).

A third justification for caloric taxes is related to a lack of information. Some argue that the growing prevalence of obesity is partly due to ignorance of consumers, particularly children, about the harmful health consequences of consuming many calories (Brownell and Frieden, 2009). Others allege a problem of lacking self-control in their eating habits or the existence of a time inconsistency of assigning a higher preference for the short-term benefits of consuming more calories (and investing less in exercise) over their long-term costs (Komlos, Smith and Bogin, 2004; Smith, Bogin and Bishai, 2005). Therefore, a tax on unhealthy foods/drinks could contribute to better appreciate the true association between higher food prices and inadequate diets⁵. Against this reasoning some argue that lack of information is highly associated with educational attainment levels and household income. Then, given that unhealthy foods are mostly consumed by the less educated and/or poorest households, taxing unhealthy foods would have an additional negative impact on their disposable income. The introduction of a fat tax can be extremely regressive, as Allais, Bertail and

Nichèle (2010) illustrated for sugar-fat products. Another interesting issue here is to know to what type of expenditures these extra funds are to be allocated given the regressivity of the tax. It would be at least desirable to achieve higher levels of progressivity by the expenditure side in order to (partly) offset the fiscal regressivity introduced by the taxation.

Fourth and, finally, it is commonly accepted that the determinants of any observed outcome can be disentangled into two components: exogenous circumstances to the individual (parental background or social gradient) and those derived from individual efforts. In fact, equity is achieved when outcomes do not depend on the environment but on individual choice. The current debate in the health political arena, thus, is about the priority that those policies trying to compensate individuals' unhealthy lifestyles should deserve when their behaviour is difficult to be observed or measured. Two additional controversial factors arise from what is naturally expected: (i) intergenerational responsibilities (say whether smoking parents' children are less responsible than those from non-smoking parents), and; (ii) genetic characteristics condition lifestyle habits. In this sense, Jusot, Tubeuf and Trannoy (2013) evidence for a French sample that the contribution of circumstances and demographics to inequalities in health is around 45%, whereas the contribution of efforts is around 7%. That is, individual effort seems to play a minor role.

The different views maintained by experts regarding the role played by taxation in combating obesity, is also seen with respect to their impact on consumers' behaviours. Fiscal intervention advocates claim that calorictaxes will bring a significant reduction of total calorie intake and therefore a decrease in body weight, while opponents point out a much modest effect on BMI as long as consumers who like sugary products can substitute toward other (non-taxed) sugary products or eat other food which could be even more caloric. Interestingly, Becker (2009) remarks that these substitutions, induced by taxation, could even increase fat and sugar consumption and raise obesity if consumers do not only purchase products on the basis of their sugar or fat content. This means that other aspects (e.g., colour, taste, fashioned products, etc.) highly modifiable by the industry matters in the decisions of consumers. In addition, as was mentioned above, the assumed (positive) impact of the tax on prices is not guaranteed or can be further questioned since this depends on a set of incidence assumptions that cannot be generalised as they come out from both the demand and the supply reactions (relative elasticities).

In contrast to taxing say, saturated fat, less discrepancy among experts seem to exist regarding taxation of the excess of sugar content in some beverages. In addition to the fact that under a nutritional point of view this consumption is worthless, if we accept that the demand of sodas has a low price elasticity, under the 'indemnity purpose', supporters of the efficient taxation principle should defend such taxes since the generated excess burden will be minimized (Ramsey principle). In addition, firms' profitability would be hardly affected if sales are not excessively altered. However, its implementation is not easy and some opposition from the industry should be expected. A positive aspect not always recognised could be that penalising sugared drinks low cost substitutes are healthier. To avoid this makes for a powerful incentive for the industry to develop low calorie beverages to offset sales. Even part of the public funds collected by these taxes could be devoted to subsidize this kind of innovations.

It is worthy to stress here some points to bear in mind before reviewing the literature. First, it seems clear that taxes on unhealthy consumption should be judged as a successful policy action if the revenues raised are low, this meaning that they have radically reduced (or even motivated to abandon) consumption. This is clearly in contrast with the view of taxing addictions, this being, to raise enough revenues from the present consumers under cost indemnity purposes and to fund prevention programs against potential future consumers. In the first case, the logic of the intervention is to allocate the maximum burden of the tax on those individuals who are sensitive enough to the relative price changes. For most addicted consumers (low or zero price elasticity) the purpose is to make them assume a larger part of the healthcare consequences derived from the consumption. Second, if this is true we need to point-out that the final impact of the fast-food taxation will depend on the available set of substitutive goods, which in this case (compared to addiction goods) is wider and less needed of further control policies. Thirdly, the impact on final consumer prices depends on a set of tax incidence assumptions that cannot be directly extrapolated from other situation experiences, since these effects will ultimately depend on the specific time and place circumstances. They may affect not only of the demand side but also of the supply reaction of the industry and more generally of the entire general re-adjustment of the economy. Fourthly, some even question that the intakes themselves should be taxed. This is due to the fact that more importantly that an unhealthy diet (intake) behind the obesity epidemic, are the lifestyles (out-takes) associated to such unbalance eating. Actually, some experts point-out the need to distort through “pigouvian” taxes the production technologies at present at work (e.g., less manual work, less physical effort exertion at work, etc.) favouring an “obesogenic” environment, since this is seen as the main factor contributing to the rapid raise of obesity in the last decades. Hence, interventions should be targeted in combating sedentary behaviours and the current productive model, instead of taxing calorie foods, since these (excessive intake and sedentary life style) are not always equally complementary for all those targeted individuals of the population.

3. Literature Review

The review was performed by one of the authors using the MEDLINE research database (EBSCOHost Research Databases). The criteria for the initial selection of the literature were that the study was published in peer-reviewed journals, covered the last 15 years (between 1st January 1998 and 2013) and in English. We searched for the terms “unhealthy food taxes” “fast-food taxes”, “beverage taxes”, “soda taxes” “sugared drink taxes” included in abstracts. This search returned 50 papers. Another author restricted even further this initial selection (dropping 19 papers) on the basis of content grounds. Since Medline is limited and excludes relevant references from Economics, by applying an inverse searching procedure we added to this list of papers other studies –subject to the same criteria conditions (i.e., peer reviewed journals) – via the references included in papers judged of interest by the authors. Finally, a number of 48 articles form the basis of our review.

The first remarkable point that emerges when assessing the set of selected papers analysing the taxation of unhealthy food is the existence of a wide diversity of objectives,

methodologies, settings and datasets, policies implemented and results achieved by all these studies, which undoubtedly adds complexity to any attempt to draw a general conclusion on fast food taxation. For instance, an important issue is to decide what type of fast food tax best achieves the desired objectives. Do we need to tax specific unhealthy foods/drinks or alternatively should the policy maker opt for taxing the nutrient content of foods (e.g., fat or salt content)? Have in mind that there is some healthy food that is rich in caloric content (for instance, olive oil or nuts). A tax on calories has been also proposed, although this option may be more difficult to implement. Do we need to introduce an explicit fat tax (e.g., a specific tax on foods whose content of saturated exceeds 2.3 g/100 g was introduced in Denmark in Oct. 2012 or the taxation of large soda drinks proposal in the state of New York) or apply a VAT extension? Others suggest that taxing all consumers is unfair and propose to tax overconsumption of fat. Another interesting issue is to decide which products are taxed and exempted, given the pressures of the food industry. Indeed, a constant re-evaluation of tax rates is perhaps needed, as the reaction of the industry may be to change the fat content quite frequently.

At this juncture, it is worthy to present in a table some practical experiences with unhealthy food taxes around the world. As it can be seen in table 1, very few countries have implemented this kind of taxes and, most of them, did it very recently. Given the recent nature of these policies, few studies have evaluated their impact on consumers' behaviour. Besides these experiences, other countries have had or are having a strong debate about the inclusion of these tax schemes (e.g., Ireland, Italy, New Zealand, Romania, Spain and the UK) following the suggestions of the WHO.

The analysis of the literature review is presented in two subsections, namely: unhealthy food (3.1) and caloric drinks and specifically sugar sweetened beverages (SSBs) (3.2). Specifically, we survey in the next sections available evidence and strengths and pitfalls from taxing these products.

3.1. Taxation of unhealthy food

To examine whether fast food taxes are an effective health policy tool to fight obesity and other health diseases, a first group of selected papers is concerned with estimating the likely response of consumers to this fiscal intervention. A summary of these studies is presented in table 2 in a synthetic manner. For instance, Kuchler, Ababayehu and Harris (2005) estimated the impacts of several ad-valorem taxes on the demand of salty snacks by estimating demand equations and using information from the AC Nielsen HomeScan panel database. They found low price elasticity values implying a very small effect on quantities purchased. Hence, the impacts on dietary quality were rather small and negligible at the lower tax rates. Even larger taxes would hardly affect the overall dietary quality of the average consumer. While ineffective means of altering diet, these taxes could however be used to raise earmarked revenues for funding healthy eating information programs. Similarly, Chouinard *et al.* (2007) estimated a system of demand equations for fourteen dairy products (a gener-

Table 1
EXPERIENCES WITH UNHEALTHY FOOD TAXES WORLDWIDE (EXCLUDING SIMULATIONS)

Country	Implementation	Political measures	Articles evaluating impact on consumption
African countries	Diverse	Among VAT countries, the ad valorem rates are as low as 2.75% in Senegal and 5% in Chad, but as high as 20% in Ghana. In Ethiopia and Angola, which do not levy a VAT, the tax rate on soft drinks is 80% and 20%, respectively.	None
Denmark	1st October 2011 Abolished November 2012	Tax paid per kilogram of saturated fat on foods (e.g., meat, dairy products, animal fats, edible oils and fats or margarine) if containing more than 2.3% saturated fats. Consumers pay 2.15 €/kg.	Short-term consumption of fats (butter, blends, margarine and oils) is estimated to drop between 10-15%
Hungary	1st September 2011	Tax on selected manufactured foods high on fat, sugar, salt or caffeine content as well as increased tariffs on soda and alcohol. Basic food is not taxed and the tax only affects those products with healthier alternatives. The value of the tax varies by product.	None
Ireland	1916-1992	From 1975-1979 the special excise tax on soft drinks (table waters) was levied at a rate of IR£0.10 per gallon produced. The rate was increased to IR£0.37 per gallon in 1980 and held at that level until July 1990 when it was reduced to IR£0.29 per gallon. The tax was abolished in November 1992. VAT rate on soft drinks was reduced from 23% to 21% in January 1992.	Soft drink prices fell 5% and consumption increased 15% due to the tax reduction in 1990-1992, <i>ceteris paribus</i> . After abolishing the excise tax, 30% of the revenue loss was estimated to be recaptured in VAT and income taxes (Bahl, Bird and Walker, 2003).
Finland	2011	Reintroduced taxes on sweets (candies, chocolate, cocoa-based products, ice cream, ice lollies etc.) that existed until 1999. The existing tax on soft drinks was also increased and its scope was widened to cover further categories of beverages. In 2014 the government will add cookies, cakes and other baked goods. Consumers pay 0.75 €/kg and 0.04-0.075 €/L, respectively. In 2012 increased to 0.95 €/kg.	None
France	1st January 2012	Tax on soft drinks and other sugary beverages (fruit juices and carbonated drinks containing added sugar). Consumers pay rate of 7.16 €/HL.	None
Mexico	October 2013	A tax increase of 8% on foods rich in saturated fat, sugar and salt; and 10% per litre of sugary drinks.	None
Norway	1922	A tax on sugar and chocolate. Consumers pay 0.86 €/kg.	None
US (New York City)	2006	Bans on trans-fat for restaurants. 18% tax on sodas was roundly rejected by the New York State Legislature in 2009.	None

Source: Own elaboration.

alised Almost Ideal Demand System –AIDS– model) by non-linear 3SLS, aimed at analysing the incidence of an ad-valorem tax on the fat content of each food. From the calculated own- and cross- prices elasticities, the authors reported a very small fiscal effect (even with a 10% tax) on quantities and fat consumption. Again, due to the low price elasticity of these goods fat taxes become an effective means of raising revenues, but were extremely regressive as elderly and poor individuals suffered comparatively much greater welfare losses.

Interestingly, the study of Mytton *et al.* (2007) pointed out unintended detrimental consequences on health caused by taxation if cross-price elasticities are not accounted for. By means of data on at-home food consumption taken from the UK National Food Nutritional Survey 2000 and other external sources, concluded that extending the 17.5% VAT rate to the main sources of dietary saturated fat is unlikely to reduce the incidence of CVD (in contrast to Marshall's, 2010, findings), because the reduction in saturated fat was offset by a rise in salt consumption. However, the taxation of a wider group of unhealthy foods could avert more deaths from CVD. Hence, the scope for significantly altering the national diet by use of the VAT seems limited. Only large tax increases could be effective⁶. In the same vein, but under a different setting, Allais, Bertail and Nichèle (2010) estimated a system of demand equations (AIDS model) and simulated the introduction of a fat tax on a set of foods high in calories. Their main conclusion was that a 10% tax on such foods led to small changes in the intake of unhealthy nutrients among French households in the short run (greater effects were devised in the long run); although this policy was judged extremely regressive falling disproportionately on poor consumers. Using i) US NHANES data, ii) existing estimates of price and income elasticities, iii) a wide range of foods and subcategories within groups and iv) allowing substitution by consumers between nutrients (i.e., low fat for high fat; low sugar for high sugar) the study by Miao, Beghin and Jensen (2012) calibrated the impact of taxing calories from added sugars and solid fats via a two-stage modelling strategy (first assume a linear quadratic demand system and second a CES for four subcategories of nutrients). Interestingly, they found that consumers respond toward leaner and lighter choices to abate the taxes. Specifically, a larger estimated reduction on calorie intake from taxing added sugar and oil fat is found once accounting for nutrients substitutions.

Given the adverse regressive distributional consequences of taxing unhealthy foods or nutrients, a number of policy makers and researchers turned the attention to institute subsidies (“thin subsidies”) to the healthiest foods. Cash, Sunding and Zilberman (2005) investigated the health effects induced by thin subsidies on retail prices of broad categories of fruits and vegetables. The article found that a 1% decrease in the average price of all fruits and vegetables meant a mean decrease of more than 6,000 cases of coronary heart disease and almost 3,000 ischaemic strokes, for a total of 9,689 prevented cases of disease.

Another group of identified studies examined the combination of taxes and subsidies to modify nutrition habits and improve health issues. On one hand, Nnoaham *et al.* (2009) examined the impact of several policies combining taxes and subsidies from survey expenditure data (years 1998-2000) and supplementary datasets within a UK context. They found

evidence that taxing saturated fat did not reduce CVD and cancer illnesses and taxing less unhealthy foods even increased the incidence of these diseases. Only the taxation of caloric foods with subsidizing the consumption of fruits and vegetables was found to have a significant effect in combating CVD and cancer deaths. In contrast, Tiffin and Arnoult (2011) simulated the impacts of a tax on saturated fat content jointly with a subsidy on fruit and vegetables using individual-level data from the UK Expenditure and Food Survey. While the tax was unable to set the overconsumption of fat at the recommendable levels, the subsidy policy achieved these goals. Notwithstanding, a negligible impact on diet-related diseases was found to cause this policy intervention. Within this framework of combining fiscal measures, Nordström and Thunström (2011) simulated the incidence of several fully funded tax reforms to raise consumers' fibre intake using a rich Swedish dataset. They estimated a demand system of grain products (a Quasi-Almost Ideal Demand System –QUAIDS– model) under the inevitable “weak separability” assumption in grain consumption, and used a two-step Heckman sample selection model to account for the zero mass problem (infrequent consumption). Modest results implied by these revenue neutral fiscal policies were reported. Specifically, these interventions failed to increase significantly the consumption of fibre, more importantly, among the households who had a low level of fibre intake before the reform (families with children). These families with children also appeared to be more affected financially (paying higher taxes and facing higher price levels) although they experienced reductions in the intake of added sugar and saturated fat.

3.2. Taxation of Sugar-Sweetened Beverages

Increasing taxation of SSBs is one of the most promising public policies for obesity prevention (see table 3 for a succinct summary of the analysed studies). Indeed, projections show significant increases in tax revenues and aggregate reductions in SSBs consumptions for the period 2010-2015 using US 2009 regional consumption levels (Andreyeva, Chaloupka and Brownell, 2011). However, these findings are not confirmed by means of individual data. Moreover, although specifically for adolescents, Powell and Chaloupka (2009) showed no statistically significant association between current state level taxes and adolescent weight, which is not surprising given the very low level of such taxes. Sturm *et al.* (2010) confirmed that small taxes did not affect state soda consumption levels.

We should note that US states sales taxes differ considerably from one state to another (Chriqui *et al.*, 2007). Likewise, differences across countries should be taken into account. Jou and Techakehakij (2012), using data from 19 countries, suggested that SSBs or soft drinks taxation policy would be more effective when obesity prevalence and soft drink consumption levels are high and the baseline tax rate is low. Thus, given that most of literature refers to US, previous evidence should be taken with caution when translating to other economies.

Specifically with regards to price elasticities, Andreyeva, Long and Brownell (2010) carried out a meta-analysis for the period 1937-2007 and estimated a price elasticity value

Table 2
TAXATION OF UNHEALTHY FOOD

Author (year)	Context (time & location)	Research question	Method	Empirical result
Allais, Bertailand and Nichèle (2010)	TNS Worldpanel 1996-2001 food acquisition data. French data	Effects of fat tax on nutrients purchased by French households	Estimation of price elasticities using an AIDS model following Blundell and Lewbel (1997), simulation of a fat tax	Highly regressive. 10% tax on food categories high in calories leads to small changes in the short run and greater long run effects
Cash, Sunding and Zilberman (2005)	US Continuing Study of Food Intake by individuals 1994-1996 & 1998	Effects of thin subsidies: consumption subsidies for healthier foods	Own price demand elasticities & simulation effects on several diseases	1% decrease in average price of fruits and vegetables decreases 6,733 cases of coronary heart diseases and 2,946 ischemic strokes
Chouinard <i>et al.</i> (2007)	Weekly US city-level aggregates of grocery store scanner data matched with household information 1997-1999	Effects of fat taxes on dairy products	Demand system for 14 dairy products by means of NL3SLS, simulate substitution effects	10% tax decrease less than 1% fat consumption, table showing states legislation
Kuchler, Abebayehu and Harris (2005)	AC Nielsen HomeScan panel 1999	Estimate consumers likely response to tax snack foods	OLS, survey weights, adjusted prices to quality. Dependent variable: quantities	Price elasticity potato chips -0.45, all chips -0.22, very small effect on quantities 1% increase in tax reduce 0.71 ounces (20 grams)
Marshall (2010)	UK data	To explore the effect of extending the VAT at 17.5% for the main sources of saturated fat (whole milk, butter, cheese, etc.) on the incidence of ischaemic heart disease	Assume values for price-elasticities of goods rich in saturated fat. Then simulates consumption changes induced by the fiscal policy. Secondly, compute reductions in calories from saturated fat and the fall in cholesterol levels applying the Clarke and Keys formulas. This translates into reductions in ischaemic disease	The paper estimates a fall in the ischaemic heart disease between 1.8% and 2.6%, which would prevent between 1800-2500 deaths per year, between 900-1300 of these in people below 75. As poor people are more sensitive to price changes (higher income share on food) and have higher risk of ischaemic heart disease, health benefits of this policy is progressive, although regressive in terms of income

Source: Own elaboration.

Table 2 (Cont.)
TAXATION OF UNHEALTHY FOOD

Author (year)	Context (time & location)	Research question	Method	Empirical result
Miao, Beghin and Jensen (2012)	25 food groups and 4 sub-categories each were defined from Dietary Guidelines and USDA data. Several national-level data sources used to calibrate the model and simulate scenarios	Examine effect on consumption and welfare of taxes levied on nutrients causing excess calorie intake (added sugar and caloric sweeteners + solid fat)	Substitution between nutrients and within nutrients is accounted for by estimating a complete demand system. Model is calibrated using US data. First stage assumes a LINGUAD demand system, second stage a CES for four subcategories of nutrients. Food consumption is then converted in nutrients intake and then to caloric intake. Welfare effects measured by equivalent variation	Accounting for nutrients substitution (low fat for high fat; low-sugar for high-sugar) has important consequences on the assessment of food taxes targeting obesity. Larger reductions in calorie and added sugar intake and welfare cost of the tax is smaller when accounting for within-group substitution. Similar holds for the tax on calories from fat. Public revenues from nutrient taxes are lower when substitution is accounted for. For instance, tax revenues from added-sugar tax is overestimated by 37% and 7% from the fat tax
Mytton <i>et al.</i> (2007)	Food consumption (at-home), expenditure and own & cross-price elasticities taken from the National Food Survey 2000 in the UK. Health effects of changing salt and fat intake from external sources (meta-analyses)	To estimate the effects on nutrition, health and expenditure of extending the VAT to a wide range of foods in the UK	Fiscal policies examined: 1) taxing the main sources of dietary saturated fat in UK (Marshall's proposal); 2) apply VAT to those unhealthy foods defined by SSCg3d instrument; 3) 17.5% VAT to foods to obtain the best health outcome. A model designed to predict changes in demand, expenditure, nutrition and health is estimated	Taxing only the main sources of dietary saturated fat is unlikely to reduce the incidence of CVD, because reduction in saturated fat is offset by a rise in salt consumption. Taxing unhealthy foods might avert 2300 deaths per year, basically by reducing salt intake. Taxing a wider range of foods could avert more deaths from CVD (3200 per year, 1.7%) in UK also by reducing salt intake. The 3 policies supposed a fall in fruit and vegetable consumption by 2-4%
Nnoaham <i>et al.</i> (2009)	Expenditure data from national survey in the UK for 1988-2000 and supplementary datasets	Effects by income group of targeted food taxes and subsidies on nutrition, health, expenditure	UK model. 4 different policies combining tax and subsidies. Own price elasticities	Taxing saturated fat did not reduce CVD and cancer diseases. Taxing less healthy foods (LHF) increased these illnesses. Taxing LHF but subsidizing fruits and vegetables significantly reduced CVD and cancer deaths

Source: Own elaboration.

Table 2 (Cont.)
TAXATION OF UNHEALTHY FOOD

Author (year)	Context (time & location)	Research question	Method	Empirical result
Nordström and Thunström (2011)	Setting: Sweden. Policy simulation consisting in a fully funded scheme. Reducing VAT rates for Keyhole-labelled bread and breakfast cereals & increasing VAT on unhealthy goods/meals. They also examine taxation of unhealthy (added sugar, saturated fat) & subsidies to healthy (fibre) nutrients across different types of households. It is a revenue neutral tax scheme. Simulation described in their 2009 paper	To analyse the effect of fiscal policies designed to increase the demand of fiber intake from grain consumption and reduce the intake of unhealthy nutrients	A demand system of grain products is estimated using the quadratic extension of the QUAIDS model. This model provides a flexible functional form of consumer preferences. QUAIDS also allow computing expenditure/income effects. Weak separability in grain consumption is introduced as cannot be observed consumption in other goods by households. Problem of zero expenditures (infrequent consumption) is modelled via a two-step Heckman sample selection model, which allow consistent parameter estimates	Modest/poor results of the four simulation (revenue-neutral) fiscal policies. Fail to increase significantly the consumption of fibre in those households who had a low level of fibre intake before the reform. Households with a larger increase in the intake of healthy products were those who were close to the recommended levels. Households with the lowest consumption of fiber intake (families with children) will pay more taxes if the reforms are implemented, raise of the price level they face. Any sizable increase in the intake of fiber was accompanied by an increase of unhealthy nutrients as well
Tiffin and Amoult (2011)	UK Expenditure and Food Survey data. A tax based on saturated fat content + subsidies on fruit and vegetables is analysed	To measure the impact of a fiscal intervention on the risks of diet-related diseases, accounting for the full range of diseases	Estimate demand equations. The model then is used to simulate the impacts of the fiscal policy. Changes in consumption are used to compute the effects on the risks of a range of diet-related diseases using measures of relative risk	The subsidy increased mean fruit & vegetable consumption to dietary recommendation levels. The tax was insufficient to achieve this goal for fat intakes. Once changes in diet are converted into changes in the risk of diseases, the impacts of the policy were negligible. A substantial share of the population continues to consume unhealthy diet

Source: Own elaboration.

of -0.79 for soft drinks based on 14 studies although the confidence interval ranges from -0.33 to -1.24 . However, since 2007 literature on taxing effects on SSBs consumption has consistently improved either in methodological procedures or the availability of individual data (Fletcher, Frisvold and Tefft, 2010; Dharmasena and Capps, 2012; Miao, Beghin and Jensen, 2013). These improvements basically consists in the consideration of repeated cross-section models using very complete datasets (such the Nielsen HomeScan or the combination of US national-level data sources) and the estimation of cross-price elasticities by means of demand systems allowing relationships between alternative beverages (milk, fruit drinks, fruit juices, bottled water, coffee, etc.) such as the LinQuadincomplete demand system (LaFrance, 1998).

A word of caution may be told here: so high range of observed results of price elasticity estimation remind us that most of the effects depend on multiple circumstances that make us to be aware of the problems of reliability of taxation policies.

In general, smaller reductions of soft drinks consumption and overall tax revenues are expected after increasing taxes on SSBs. Modest significant impacts on consumption are evidenced after rising taxes around 20% although its impact on daily caloric intakes is pretty small. Finkelstein *et al.* (2010), using the Nielsen HomeScan Panel database, estimated 7.8 kcal/d reductions after increasing taxes on carbonated SSBs at a rate of 40%. However, in a recent paper Finkelstein *et al.* (2013) revised previous findings for the same database obtaining higher estimates for consumption reduction (24.3 kcal/d) once increasing taxes by 20% through the use of a two-part model estimation procedure and correcting for endogeneity problems. Using the same database, Lin *et al.* (2011) estimated a significantly lower impact of a 20% increase tax in SSBs on children loss weight once dynamics was accounted for.

Interestingly we should note that these small taxation impacts on consumption mainly rely on the presence of substitution effects. Although individuals do not seem to shift to alternative sugary products (Finkelstein *et al.*, 2013) higher taxes on SSBs make individuals increase their consumption of alternative high caloric beverages such as whole milk among children and adolescents (Fletcher, Frisvold and Tefft, 2010), higher caffeine intakes (Dharmasena and Capps, 2012) or to alternative within-group substitution beverages with dissimilar nutritional content - based on low fat vs. high fat and low sugar vs. high sugar (Miao, Beghin and Jensen, 2013).

4. Discussion

Taxing unhealthy food has become in many countries one of the most debated public health policies to fight the obesity pandemia. While tax revenues have increased significantly, actions targeted to promoting physical activity or healthy food at schools have generated costs. The short-term effectiveness of these programs at primary ages have made them very promising. In contrast, our literature review leads us to conclude that the consumption of un-

Table 3
TAXATION OF SUGARED SWEETENED BEVERAGES (SSBS)

Author (year)	Context (time & location)	Research question	Method	Empirical result
Andreyeva, Long and Brownell (2010)	US literature: 1938-2003	Review of research on price elasticity of soft drinks	Meta-analysis based on 14 studies	Overall price elasticity ranges from -0.27 to -0.81 but specific values are obtained for several groups of products. Examined sensitivity of results because of study designs differences. Limited research for several products
Andreyeva, Chaloupka and Brownell (2011)	Regional consumption of SSBS for US in 2008 and several trends of consumption	Estimate the change in public revenues from an excise tax on SSBS	Projections assuming last growth changes, population census projections and price elasticity from Fletcher, Frisvold and Tefft (2010)	Increased regional tax revenues period 2010-2015 and also reductions in consumptions
Dharmasena and Capps (2012)	Monthly time series data from the 1998-2003 Nielsen Home-Scan dataset	1. To estimate own- and cross-price elasticities of selected non-alcoholic beverages; 2. To estimate DRs; 3. To estimate direct & indirect effects of a tax on SSBS on beverage consumption, calorie intake and change in body weight/obesity	Setting: sample of urban and rural households in the US. Selection of 10 non-alcoholic beverages (including milk, fruit drinks, fruit juices, bottled water, coffee) allowing a high disaggregation. Propose a 20% tax on 3 SSBS (i.e., isotonic, non-diet soft drinks and fruit drinks)	A 20% tax on SSBS for just 3 products (isotonic, non-diet soft drinks and fruit drinks) reduced consumption of these beverages. Also raised notably the consumption of non-SSBS (fruit juices, coffee and tea) which are unintended consequences (add more calories + caffeine) but raised low-fat milk (positive). Taking direct and indirect effects into account it is found a small reduction in per capita body weight (0.7 a 1.2 Kg) per person and year, in part explained by the substitution of consuming more caloric beverages (fruit drinks) instead of the taxed products
Finkelstein and Strombotne (2010)	2006 Nielsen Home-Scan panel data referred to US households, monthly data, income groups by quartiles	Estimate different impact of SSBS taxes between high/low income households	Estimations follow a two-part model (Logit+OLS) and several tax simulations are conducted (on carbonated SSBS and all SSBS). Monthly level data is used. Controls on household characteristics (including income and education) are accounted for. Crude estimations on per capita weight reductions and tax revenues were obtained.	A 20% and 40% tax reduce purchases of carbonated SSBS in very small amount (4.2; 7.8 kcal/day). Extension to all SSBS yields very similar results and weight losses are also low (between 0.32 and 0.59 kg per person/year), mostly driven by households in the 2 middle income quartiles

Source: Own elaboration.

Table 3 (Cont.)
TAXATION OF SUGARED SWEETENED BEVERAGES (SSBS)

Author (year)	Context (time & location)	Research question	Method	Empirical result
Finkelstein and Strombotne (2013)	2006 Nielsen HomeScan panel data referred to US households	To estimate the impact of a SSBS tax on changes in energy, fat and sodium intakes and also on bodyweight, when considering substitution to other foods (high in calories) in addition to drinks	Two-part Model (Logit+GLM with log link-Gamma distribution). The effects of SSBS taxes use IV estimation as prices may not be exogenous. Quantile regression is also used.	The predicted 24.3 kcal/per day (per household member) reduction in energy predicted by the model would imply a 1.6 pounds weight loss and accumulated weight loss of 2.9 pounds after 10 years. IV results indicate that substitution to other beverages was limited (only to juice fruits). No evidence is found toward substitution to other sugary products. The tax reduced energy purchases by both heavy SSB and total calorie purchasers
Fletcher, Frisvold and Tefft (2010)	Child and adolescent US states data on soft drink sales and excise taxes between 1989-2006 and NHANES data	To estimate the effects of soft drink taxes on consumption to combat child and adolescent obesity	Estimate a state and year FE model using repeated for cross-section of the NHANES datasets. elasticities. Shift to other beverages (cross-price elasticities) is accounted for. OLS estimating procedure, standard errors clustered at the state level	Modest reduction in soft drinks consumption and calories consumed by children and adolescents is found. This effect was completely offset by the consumption of other high calorie beverages such as whole milk. Ineffective obesity tax as soda taxes do not reduce weight in children and adolescents. To achieve a reduction of soda consumption of 100 cal/d would require a 16% tax rate rise.
Lin <i>et al.</i> (2011)	1987-2007 National Consumer Panel US (Nielsen) & NHANES Repeated cross-sections (1997-2006) of individual data (8th, 10th and 12th grade students) from the Monitoring the Future (MTF) surveys + external state level data on soda taxes and local area contextual information. Self-reported adolescents' BMI info	Static versus dynamic energy reductions bias in static models To examine the associations between state-level taxes on soda sold in grocery stores and vending machines and adolescents' BMI	Compute price elasticities from a static model (AIDS-Deaton) and cross-elasticities	Time path weight loss from static models overestimate impact years after tax implementation No statistically significant association between state-level soda taxes (in grocery stores or vending machines) and adolescent BMI. This result is robust to several specifications. Only a small and weak significance (10%) positive effect was found between vending machine soda tax rates and BMI among overweight teens (but not by grade, gender or parent's education). Not surprising given the very low level of such taxes
Powell and Chaloupka (2009)				

Source: Own elaboration.

Table 3 (Cont.)
TAXATION OF SUGARED SWEETENED BEVERAGES (SSBS)

Author (year)	Context (time & location)	Research question	Method	Empirical result
Sturm <i>et al.</i> (2010)	State sales taxes for soda, ECLS-Kinder- garten cohort (panel)	Effects of small taxes on con- sumption and weight gain	Dependent variables: soda consumption last week, soda purchase at school, change in BMI. GLM (gamma + log) for taxes and consumption whereas OLS for taxes and BMI	Such taxation did not affect soda consumption

Source: Own elaboration.

healthy food (fast food and soda drinks) has not been significantly affected by the introduction (extension) of new (pre-existing) taxing schemes. In general, only high tax rates (around 20%) are required to slightly change individual consumption behaviour. Additionally, these small changes in purchases have also implied insignificant changes in daily energy intakes once researchers have taken into account cross-price elasticities and used procedures that allows for the substitution effect within and between food categories. In consequence, small changes are also expected in BMI and overweight and obesity prevalence rates.

Some literature has proposed the combination of subsidies (to encourage non-obesogenic food) and taxes (to discourage caloric eating) to transform the diet of the average consumer. Among the products to be subsidized fruits and vegetables are the most promising given its lower current affordability and their lower (not saturated) fat concentration compared to other food products. Likewise, children living in disadvantage households are more price sensitive for these kind of products compared with their non-poor and not-at-risk counterparts (Powell and Chaloupka, 2009). However, not only subsidies should be applied but also promotional activities favouring their consumption at initial ages (Cuffe *et al.*, 2012). It has been shown that the treatment of obesity in adult life via the introduction of changes in lifestyles is extremely difficult (Hill, 2009). For this reason, many interventions aimed at modifying food habits and promoting physical activity so as to reduce the prevalence of obesity, have targeted schoolchildren. In any case, either taxes or subsidies are not free of labour and administrative costs and erroneous farm subsidies might increase obesity rates (see Faulkner *et al.*, 2011 for a review). Not to mention the fact that subsidies may be capitalised without producing the expected effect of reducing prices of healthy food.

In addition, and given that the aim of taxation policies is to change unhealthy behaviours, it should be clear that they should focus more price sensitive consumers, likely to be those low income groups and young people. The effect for them may be reinforced by applying part of the revenues to education and programs for accompanying changes in their life styles. Without this, the regressive redistribution nature of the income impacts may question a general implementation of the policy.

Another issue constitutes the fact that these new taxing schemes are extremely regressive, as obesity is mostly concentrated in the lower income deciles (Costa-Font and Gil, 2009). The latter is linked with the lack of adequate information. Low income households and individuals with lower educational levels would react showing myopia in their purchasing decisions. In this sense, it is recommendable to introduce new taxing schemes but also advertising campaigns basically at schools to reduce unintended substitutions of current products by others with a similar or worst risk for individual health. Note that changes in lifestyle behaviours are more likely to occur at initial ages rather than in adulthood.

Not surprisingly, the industry has become reluctant to the introduction of fat taxes and has even promoted anti-tax campaigns in the case of SSBs taxes. The recent abolition of the world's first tax on saturated fats (imposed in 2012) by the Danish government has also been widely celebrated by farmers, retailers and shoppers for some sided effects⁷. However, if

governments are not introducing these new taxes to solve their deficits in public budgets, extra revenues can be returned in the way of tax deductions to the industry to promote R&D in healthier products. This proposal constitutes a Pigouvian tax internalizing the externality and adjusted to the Ramsey rule that minimizes the excess burden with higher tax rates inversely proportional to the demand elasticity. This makes the tax more socially accepted because and being less regressive.

All the reviewed studies seem to have neglected one aspect that can be considered crucial for the understanding of the real impact of fast food taxes, but the literature of smoking has however highlighted. Namely, the likely reaction of the food/drinks industry, some of them under powerful oligopolistic settings, to modify prices or whenever possible the introduction of new varieties in order to accommodate the impact of higher tax rates. These set of responses would clearly work in the direction of attenuating the impact of the taxation policies and avoiding changes in the consumption patterns.

Several criticisms arise after having summarized the empirical impact of taxes on unhealthy consumption. First, some studies are based on elasticity values extracted from other contexts and time periods, which may be at least questionable. General speaking, elasticities which describe consumers' reactions to prices are country and cultural context specific. For instance, complements and substitutive goods tend to be diverse across countries: while pizza is eaten with soda in some countries, in some others go with wine. This simple difference has obvious consequences on cross-price elasticities and the final impact of the taxation. In this sense, idiosyncratic specific effects must be accounted for when estimating price elasticities of these kinds of products. Thus, there is room for more country analyses and experiments to investigate individual reactions to changes in prices/taxes. Second, as Cash and Lacalino (2007) point out, elasticity estimates to simulate substantial price changes suffer an inferential issue given that predicts values outside of the observed range of the data. This may need some additional accurate treatment. Third, the universe of substitutes of SSBs and unhealthy food is so extensive that empirical approaches cannot cover all substitutions across categories of food. Obviously, demand systems should be estimated since it allows for substitution between food categories, with different levels of aggregation, but it ignores any substitution effect either within food categories or between different goods (Allais, Etilé and Lecocq, 2012). Indeed, the level of aggregation alters the estimated impact. Fourth, many studies rely on self-reported or cross-sectional data. Self-reported data poses the debate on the difference between desired and observed consumption. Apart from this, not all the products/goods are considered in survey questionnaires. Furthermore, food balanced sheets are recorded at the primary level or intermediate commodities which are not the final products usually purchased by consumers. This complicates the systems of demand to be estimated. In this sense, 'scanner' data (e.g., the AC Nielsen HomeScan panel) is preferable than the self-reported one, although the usual lack of relevant socio demographic factors in the former tend to condition unhealthy food consumption patterns. Fifth, more recent literature have accounted for substitution effects which are strongly relevant given that consumers can switch current intakes for other ones that are unhealthy too. But an additional problem here comes from the asymmetry and heterogeneity in products substitution. Likewise, defi-

nitions, such as that for a soft drink beverage are not strictly defined by literature. Without taking into account most of these issues, estimated prices responses are somehow artificial. Sixth, as we stated throughout the paper, individual heterogeneity is not fully addressed with the use of cross-sectional data. In this regard, panel data empirical is needed. Seventh, producer responses are very difficult to be accounted for. As a result, several products might be taxed simultaneously. Finally, with regard to policy implementation in developed countries, regressivity cannot be avoided and differential taxation based on subgroups of consumers is very difficult to implement.

Notes

1. However, other researchers attribute to the reduction in time costs of preparing meals (processed food, food packing and transport and kitchen appliances) the key factor explaining the rise in obesity levels (Cutler, Glaeser and Shapiro, 2003).
2. Against this argument, Bhattacharya and Sood (2013) suggest that any subsidy obese people receive via pooled health insurance is offset by wage differentials. Interestingly, they indicate that the wage gap (in detriment of the obese) holds only in jobs that provide health insurance and has a close link with the difference in expected medical expenditures between obese and thin individuals.
3. Another external cost caused by obese adults (usually not considered) refers to those children that as a result of a parenting failure (lack of enough parental guidance and care) become more ignorant on the consequences of obesogenic intake or have been transmitted unhealthy lifestyles and hence obesity. The lack of an insurance against parents' inappropriate care giving leads children bearing the costs (Gable and Lutz, 2000).
4. Similarly, against this externality argument Becker (2009) writes "Would those who advocate taxes on beverages and other foods, because obese persons make use of publicly funded health services, support a subsidy to smoking if smoking cuts the use of health care and social security benefits? Clearly not, and nor should they".
5. However, other public actions could be more effective in dealing with the lack of sufficient information. For instance, food providers could be required to publicize the nutritional and caloric content of the foods sold (e.g., the Nutrition Labelling and Education Act of 1990 in the US) or requiring calorie labelling on menus in restaurants. Posner (2009) prefers imposing bans on very aggressive advertising campaigns targeted to children, although this intervention could lead to higher prices if entry to the industry is reduced.
6. However, the authors recognise some limitations of their study. For instance, no attention is given to the effect of other nutrients on health or the fact that food eaten outside home is not affected by taxation.
7. One study found 48% of Danes doing some cross-border shopping to Germany and/or Sweden to avoid the tax (The Economist, 16/05/2013).

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Resumen

Este artículo pretende, a través de la revisión de la literatura más relevante al respecto, aportar nueva luz sobre las potencialidades y los límites de la tributación de los alimentos/bebidas no saludables con el propósito de alterar los estilos alimentarios de la población y combatir, de este modo, el fenómeno de la obesidad. Se constata la existencia de una amplia diversidad de objetivos perseguidos, metodologías y entornos investigados y bases de datos empleadas, políticas implementadas y resultados obtenidos, que añaden complejidad a cualquier intento de derivar una conclusión genérica y válida sobre la imposición de las grasas o bebidas calóricas. Buena parte de los estudios valorados predicen un efecto modesto de tributar el consumo de comidas y bebidas poco saludables y, en consecuencia, un efecto escaso sobre la disminución de la obesidad, por el juego de diversos factores entre ellos los efectos de las elasticidades precio cruzadas.

Palabras clave: tributación comidas no-saludables, *fast food*, bebidas calóricas, obesidad.

Clasificación JEL: H310, I12, I18.