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Effectiveness of a carbon tax to promote a climate-friendly food consumption

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1. Introduction

Our current dietary habits are a major contributor to climate change because the "seed-to-table" food chain produces an immense amount of greenhouse gases (GHGs) (Castellón et al., 2015). For instance, in Spain, the agricultural sector contributes 14% of the country's total greenhouse gas (GHG) emissions (Bourne et al., 2012). Hedenus et al. (2014) showed that emission reduction in the agro-food sector can be achieved by: (1) productivity improvements; (2) technological changes (supply-side measures); and (3) changes in consumption behaviour (demand-side measures). Supply side measures such as command-and-control regulations, cap-and-trade systems or Pigovian (corrective) taxes, have been applied extensively in the European Union (Máca et al., 2012). However, the use of command–and-control measures has been found to be economically inefficient and does not lead to optimal production, when compared to cap-and-trade measures or Pigovian taxes (Burchell and Lightfoot, 2001).

Pigou (1928) proposed that governments should influence the behaviour of economic agents causing negative (positive) externalities through taxes (subsidies) (Endres, 2010). Influencing suppliers through taxes is a delicate issue because of "carbon leakage[1]" (Wirsenius et al., 2011) and high monitoring costs (Schmutzler and Goulder, 1997). From the demand side, the relevance of a Pigovian tax on unhealthy/high-carbon-footprint foods is justified under the assumption that the food industry is close to perfect competition.[2] Under such an assumption, the incidence of a Pigovian tax is irrelevant, whether applied to the supply side or the demand end. For this reason, several studies have shown that imposing Pigovian taxes on food demand rather than on food supply constitutes a cost-efficient emission reduction strategy (Edjabou and Smed, 2013). Consumption taxes are also more attractive from the climate perspective (Mytton et al., 2012). Säll and Gren (2015) and Wirsenius et al. (2011) argued that the tax should be imposed on consumption and not directly on the emissions. This preserves the competitiveness of domestic products in relation to imported ones and it efficiently allows consumers to adjust to the taxes according to their efficient level of consumption (internalizing the externality).

Influencing consumer behaviour through food taxes is not new. Several countries have introduced taxes on food consumption as a way of internalizing negative externalities associated with the intake of unhealthy and environmentally unfriendly food products (Springmann et al., 2016). In an attempt to improve health, in 2010 Denmark increased the existing taxes on some sugar products, soft drinks and cigarettes and introduced a tax on saturated fat in October 2011 (Smed, 2012). In 2011, Hungary also passed an excise tax on foods and beverages high in caffeine, fat, and sugar, which included both soft drinks and energy drinks (Escobar et al., 2013) with the objective of internalizing the cost of obesity related diseases. Similarly, Finland, in 2011, introduced a tax on sweets, ice-creams and soft drinks. Following Hungry, Denmark and Finland, France introduced the 'soda tax' in January 2012 with the aim of reducing unhealthy consumption of sugar or sweeteners (Berardi et al., 2016). The Mexican government in September 2013 imposed excise taxes on sugar sweetened beverages and a sales tax on several highly energy dense foods (Colchero et al., 2016) to reduce the prevalence of obesity and related diseases. Berkeley (California, USA) has taxed sugar-sweetened beverages (Cornelsen and Carreido, 2015).

In a meta-analysis, Escobar et al. (2013) showed that increasing the prices of sugar-sweetened beverages (SSBs) led to a reduction in the prevalence of obesity and overweight. Jensen and Smed (2013) found that the consumption of fats in Denmark dropped by 10% following the fat tax in 2011 while a later study by Smed et al. (2016) found that the consumption of saturated fat decreased by about 4–5% on average. Escobar et al. (2013), Jensen and Smed (2013) and Smed et al. (2016) provide evidence that seems to suggest that taxes on food can change

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[1] The European Commission defines carbon leakage as the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints.

[2] According to Edjabou and Smed (2013) food markets are characterised by near-perfect competition, which implicitly assumes that the tax incidence between food producer and consumer does not depend on whether it is the producer or the consumer who is taxed since, on a long term basis, the tax in both cases is likely to end at the consumer. We acknowledge that a deviation from this assumption will have serious consequences on our results. As such the result should be interpreted with caution.

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consumption behaviours and internalize the associated negative externalities.

Based on the evidence provided, the objective of this paper is to evaluate the potential effects of imposing a "Pigovian" CO_2 equivalent tax on food products in Catalonia (North-East Spain). From food demand elasticities, we show that levying a CO_2 equivalent tax has three effects: (1) reduction in the consumption of high carbon footprint foods with consequences on nutrient intake and the quality of diet; (2) a reduction in GHG emissions; and (3) welfare effects.

Despite the increasing importance of this topic in the policy arena, as well as among researchers, to the best of our knowledge, only a very few papers have been published dealing with the impact of taxation of unhealthy food consumption on CO_2 equivalent emissions reduction (Briggs et al., 2013; Edjabou and Smed, 2013; Garcia-Muros et al., 2017; Säll and Gren, 2015; Wirsenius et al., 2011). Wirsenius et al. (2011) found that EU-27 could reduce approximately 32 million tons of CO_2-eq if they imposed a GHG weighted tax on animal food products corresponding to 60 Euro per ton CO_2-eq. Similarly, Edjabou and Smed (2013) internalizing the social costs of greenhouse gas emissions by imposing CO_2-eq consumption taxes on 23 different foods found that emission would decline by 2.3–8.8% and 10.4–19.4% in the least and most efficient scenarios, respectively. Säll and Gren (2015) extended the work of Wirsenius et al. (2011) and found that imposing a tax on all meat and dairy products decreased emissions of GHG, nitrogen, ammonia and phosphorus from the livestock sector by up to 12%. Garcia-Muros et al. (2017) evaluated the implications of levying consumption taxes on food products in Spain based on their carbon footprint. Using demand elasticities computed from the LAIDS model showed that a CO_2-eq tax policy could reduce emissions and, at the same time, help to change consumption patterns towards healthier diets.

The above papers provide sound empirical evidence that taxes on food products based on their carbon footprints can lead to decreased CO_2-eq emission and improve dietary compositions. However, they are not exempted of criticisms. From a methodological point of view, past studies have relied on the AIDS model, ignoring the impact of unobserved household heterogeneity in welfare estimates. The second criticism is that with the exception of Edjabou and Smed (2013), who considered 23 food categories, past literature usually considered a reduced number of food products (meat, meat and dairy, etc.), ignoring potential substitution effects among the included food categories and those categories excluded from their analysis. In the case of Spain, only Garcia-Muros et al. (2017) have dealt with the distributional effects of carbon-based food taxes. However, our study differentiates from the later in several issues: (1) as mentioned, the demand model used in this study is more flexible about the functional form of the Engle curves and takes into account unobserved household heterogeneity in the welfare calculations; (2) the geographical scope is different, as our study is concentrated on a Spanish region - Catalonia; (3) tax scenarios are different with this study focusing on current EU medium- and long-term emission reduction objectives; and (4) this study focuses on revenue-neutral (compensated) scenarios.

The remainder of the article is structured as follows. Sections 2 and 3 describe the data and the methodological framework used in this study. Section 4 shows and discusses main results. The paper ends with some concluding remarks and limitations.

2. Data

This study uses microdata: home scan panel data from a sample of 1146 households[3] in Catalonia (Northeast Spain) collated by Kantar Worldpanel. From the total of 1146 households, only those who had remained in the sample for at least 45 weeks were considered. Purchased quantities and expenditures for each single food product reference have been aggregated to the annual level for each household. The data set contains all day-to-day records of food purchases of Catalonian households in 2012. Each record in the Kantar data set contains detailed product information down to the Universal Product Code (UPC) level, including the store in which the household makes the purchases, product weight, price, unit of measurement, product characteristics (such as container type, brand, and flavor) and some household socio-demographic characteristics such as nationality, age, social class, presence of kids, number of pets, size of pets etc. Households also recorded, in a book, non-UPC items as fresh fruits or vegetables, and in-store packaged breads and meats.

Using established Spanish Ministry of Agriculture nutrition-based guidelines, food products have been aggregated into 16 food categories[4] (alcoholic drinks are not included, while non-alcoholic drinks are included in the residual category for the purpose of this paper): (1) Grains and grain-based products, (2) Vegetables and vegetable products, (3) Starchy roots, tubers, legumes, nuts and oilseeds, (4) Fruit, fruit products and fruit and vegetable juices, (5) Beef, veal and lamb; (6) Pork, (7) Poultry, eggs, other fresh meat; (8) Processed and other cooked meats, (9) Fish and other seafood, (10) Milk, dairy products and milk product imitates, (11) Cheese, (12) Sugar and confectionary and prepared desserts, (13) Plant based fats, (14) Composite dishes (animal and vegetable composite dishes), (15) Snacks and other foods, (16) Residual category.

To standardize the products, all quantities were converted into kilograms and prices into euros. Similar to Zhen et al. (2014) the lowest level of aggregating the price data was the brand level. The brands were identified as belonging to subgroups and then to one of the 16 commodity groups.

To circumvent the problem of unit values encountered in cross-sectional data,[5] we followed Diewert (1998) to construct Fisher price indices[6] for the 16 food groups in our data using brands as the lowest level of aggregation. The Fisher price index, which is the geometric mean of the Laspeyeres and Paasche indices, represents the deviation of the price paid by a household relative to the average household. For instance, to construct the price index for the residual category, we followed the following procedure:

(1) Determination of the price per unit for a relatively homogeneous in-quality product. In this case, the unit value for the aggregate product g within food category j for the h-th household was calculated as:

$$UV_{gj}^{h} = \frac{\sum_{m=1}^{M} p_{mgj}^{h} * q_{mgj}^{h}}{\sum_{m=1}^{M} q_{mgj}^{h}} \quad (1)$$

where p_{mgj}^{h} is the h-th household price of the m brand in aggregate product g within the food category j, and $q_{mgj}^{h}$is the h-th household quantity purchased of the m brand in aggregate product g within the food category j.

[3] The sample is designed to represent the sociodemographic characteristics of households in Catalonia. Each household is assigned a weight in order to estimate total consumption for Catalonia. In this study, working with the raw data, only rural households are slightly underrepresented.

[4] The percentage of households with zero expenditures in the 16 food categories is shown in Table 1.

[5] We have aggregated our panel to a cross-sectional data for the following reasons: first, seasonality effects have to be taken into account. Some seasonal effects are easy to handle but others are not so easy. In case we had had three or four years, this issue would not have been a problem; second, and more relevant, the number of zero purchases increased significantly adding an additional econometric issue. We tried a double hurdle model for that but the joint estimation of a 16-equation multivariate probit and the EASI model was not econometrically feasible due to convergence problems.

[6] Secondly, by implementing the Fisher price index we able to reduce the level of heterogeneity bias in the aggregation of our data into a cross-sectional data and abstract out quality variation due to product heterogeneity (Silver and Heravi, 2006; Zhen et al., 2014)