An Environmental Fiscal Food Policy: Uniform vs. Proportional Tax Rate

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Abstract

The global food system is estimated to contribute to 30% of total Greenhouse gas emissions. The issue of how to incentivize consumers modifying their diet is crucial. We consider here food taxation scenarios aiming at reducing environmental emissions through different CO2tax options. Data proceed from Kantar purchases for food-at-home of French households on the 1998-2010 period. Our main result is that a uniform tax scenario, set at a 20% rate, induces a greater emissions reduction than a proportional to emissions tax scenario, based on a 50€/tCO2 carbon cost. Therefore a 20% tax scenario on targeted foods could result in a better incentive to consumer choices in an environmental perspective. Moreover, the implementation of a VAT increase is probably easier than any other tax regulation.

Keywords: carbon tax, food policy, sustainability

JEL: C35, D12

Introduction

The global food system is estimated to contribute to 30% of total Greenhouse gas emissions (GHGE) (WEF, 2010). Due to the expected population growth and evolution of eating habits, the rising demand for resource-intensive food products will increase the contribution of agriculture and food to environmental degradation and climate change (Foresight, 2011). In this context, the European Commission set its goal at 40% reduction in GHGE until 2030, and is about to vote in March 2015 a further recommendation of 60% reduction until 2050. Given the importance of this commitment, improvements must be realized in all sectors and at both levels of production and consumption. Recently, a number of European studies have been focusing on the impact of diet change on GHGE, involving mainly meat reduction (Scarborough et al., 2014; Vieux et al., 2012). The issue of how to incentivize consumers modifying their diet is crucial: environmental policies at the food consumption level favour up to now information tools and primarily focus on the implementation of green labelling. However, relying on an informed consumer may not be enough, and taxation implementation is in debate.

Taxing foods at the consumer level has been a popular topic on nutritional grounds (for a survey, see Thow et al. 2010), and the carbon tax the focus of climate concerns focusing mainly in energy sector. However, facing both obesity and global warming challenges, the issue of taxing foods to promote a diet reaching lower GHG emissions as well as favourable health effects remains a desirable “win-win” scenario, not yet achieved.

Very few studies examined such food CO2 taxation scenarios. They simulate different options for taxation, but are not comparable regarding the range of foods targeted, or the tax rate. Edjabou and Smed (2013), in a revenue neutral scenario, introduce differentiated climate taxes on all foods, compensated by a 25% reduction in VAT. Briggs et al. (2013) in the UK case simulate 2 scenarios on higher emitting foods. One is based only on taxation, the second one as a cost-neutral scenario: the revenue generated by taxes is used to subsidise food groups with lower-emitting foods. Finally, Caillavet et al. (2014) in the French case simulate a uniform tax targeting 2 different sets of animal-based foods.

We deal here with the incidence of those methodological issues: the choice of the food groups targeted and the technical basis of the CO2 tax probably induce great variation in results. To measure the sensitivity of results to such methodological choices which may have important consequences on nutritional and environment impacts of taxation, we compare 2 scenarios with different options: uniform rate *vs* proportional to emissions rate. We measure their impact on environmental emissions and nutrient content through several indicators. Our application concerns the purchases of French households over the 1998-2010 period. In the framework of a consumer CO2 tax, without considering at this stage the supply conditions, our study aims at providing more elements for decision-making in the perspective of a sustainable food policy.

Material and Methods

Food purchases, environmental emissions and nutrient content

We built a dataset matching food purchasing with GHG emissions and caloric content of individual food items.

Consumption data come from Kantar Worldpanel data. This survey registers household purchases for food-at-home and delivers quantities and expenditures for a wide range of food products. Due to the structure of data, we define cohorts to capture income, age and regional heterogeneity. Household data are aggregated to obtain a pseudo panel and recover the total food-at-home expenditure. It includes 48 cohorts and 169 time periods, i.e., 8,112 observations. Descriptive statistics of our sample are in table 1.

	Mean	Std. Dev.
Without children	0.501	0.333
With at least one child ($<$15)	0.338	0.308
Low degree diploma	0.417	0.167
Level of baccalaureate	0.153	0.084
Baccalaureate and higher degree	0.235	0.204
Homeowners	0.527	0.246
Farmers	0.012	0.023
Craftsmen	0.025	0.023
Executives	0.127	0.149
Intermediary professionals	0.185	0.137
Employees	0.174	0.115
Workers	0.176	0.159
Retired	0.261	0.364
Income [900; 1,500[	0.205	0.213
Income [1,500; 2,300[	0.249	0.175
Income [2,300; 3,000[	0.175	0.153
Income [3,000; [	0.285	0.313

Table 1. Percentage of Households for Each Sociodemographic Variable (8,112 observations)

Environmental data are collected by Greenext, an environment consultancy, which assigns the environmental impact of 311 food products through Life-Cycle Analysis, using ISO14040-44 standards including each life-cycle stage (production, transformation, distribution, use and end-of-life) of food products. Using a top-down approach combining French trade and production data, the final value for several indicators reflects the average food product as consumed on the French market. They are illustrated by the following three variables: (1) CO2 gives the Carbonic dioxide emissions (in grams of CO2 equivalent per 100 g), which relates to the impact on climate change, namely, GHGE; (2) SO2 gives the Sulfur dioxide emissions (in grams of SO2 equivalent per 100 g), which relates to air acidification ; (3) N gives the Nitrogen dioxide emissions (in grams of N equivalent per 100 g), which is directly related to the eutrofication of water (e.g., green tides).

The energy and nutrient content of the foods purchased is based on the national food composition Ciqual Database[1] provided by the French Agency for Food, Environmental, Occupational and Health and Safety. It gives the amount of calories per 100g of edible part for each food item. The average content of food-at-home purchases is 3081kcal/day per household. Apart from energy intake, a set of 15 nutritional indicators is computed and presented in this analysis.

Concerning *food classification*, we grouped food items into 21 food groups taking into account the environmental emissions and the nutritional content of the products (Masset et al., 2014), consumer preferences and consumer willingness to substitute products within categories of foods. The choice of food groups is particularly important when designing a food policy which involves environmental and nutritional aims. For environmental targeting, plant-based products were separated from animal-based ones. Furthermore, beef as the main ruminant meat was separated from other animal-based products. To add joint nutritional targeting, foods were distinguished according to their energy, fats, sugar and sodium content. The corresponding budget shares by food groups are reported in table 2.

[1] Available from: http://www.ansespro.fr/tableciqual.

Price elasticities

The price elasticities are given in Caillavet et al. (2014). They proceed from the estimation of an EASI demand system, which includes 21 demand equations, and socio-demographics for controlling household's heterogeneity. The own and cross-price elasticities of demand have been used to compute nutrient and environmental elasticities. They carry on substitutions between food groups as well as budget constraints of households. Because they enable to measure the percentage change of quantity due to a variation of prices by 1%, they are necessary to evaluate the impact of a taxation food policy.

	Food Groups	**Labels**	**Budget-shares**	
			Mean	**Std. Dev**
1	Juices	Juic	0.051	0.011
2	Alcohol	Alc	0.100	0.025
3	Soft drinks	Soda	0.039	0.011
4	Bottled water	Wat	0.055	0.010
5	Coffee and tea	Cof	0.046	0.007
6	Fresh fruits and vegetables	FFV	0.027	0.005
7	Spices	Spices	0.015	0.004
8	Plant-based foods high in fats	VHF	0.027	0.005
9	Plant-based dishes	VD	0.038	0.009
10	Plant-based foods high in sugar	VHS	0.038	0.009
11	Starchy foods	Starch	0.023	0.003
12	Processed fruits and vegetables	PFV	0.023	0.003
13	Beef	Beef	0.087	0.020
14	Other meats	OM	0.059	0.009
15	Cooked meats	CM	0.047	0.006
16	Animal-based foods high in fats	AHF	0.027	0.004
17	Cheese	Cheese	0.079	0.020
18	Fish and seafoods	Fish	0.056	0.013
19	Dairy Products	Dairy	0.062	0.014
20	Prepared mixed meals	PrepM	0.049	0.010
21	Prepared desserts	PrepD	0.052	0.008

Table 2. Budget structure of food-at-home purchases

Simulation scenarios

Choice of the foods targeted

High emitting foods are the target for an environmental tax. The choice of the foods targeted will be made using the same approach as in Briggs et al., i.e. by applying a GHGE tax to each food groups with emissions greater than the average level of emission computed in our data. The food groups targeted are the same in our 2 scenarios.

Choice of the tax rates

For a uniform tax scenario, we choose a 20% tax rate, which can be assimilated to a VAT increase. Indeed, taxation studies advise this is the minimum rate for expecting health impacts (Mytton et al., 2012; Zhen et al. 2014).

For a proportional tax scenario, fixing the price of CO2 is an issue in itself. It exists a wide range of estimates for the social costs of GHG emissions. Brigg's study in the UK case applies 27.19£/tCO2. Edjabou and Smed test two prices: 0.26 and 0.76 DKK/kgCO2. At current exchange rates, these prices correspond respectively to 37.72€ in the UK case, and 34.91 to 102.04€/tCO2 in the Danish case. In the French case, the rapport Quinet (2009) recommends values of 32€ in 2010, 56€ in 2020, 100€ in 2030, 200€/tCO2 in 2050. For our estimation, we take an average rate of 50€/tCO2.

Two scenarios:
Therefore, we simulate the two following scenarios:

(A) Uniform tax scenario: a tax rate of 20% is applied on food groups with emissions greater than the average level of emissions

(B) GHGE-proportional tax scenario: a tax rate of €5/tCO_2e/100g of food is applied on food groups with emissions greater than the average level of emissions.

Table 3 reports GHG emissions for each food group for which price elasticities are estimated. It provides for scenarios (A) and (B) the levels of taxation applied to each food group.

Results and discussion

Food groups taxed
According to our computations, the mean level of emission across food groups amounts to 2.14 kgCO2/100g. Therefore the food groups above this emission level and candidates for taxation are 11 over the 21 studied (table 3). They include animal-based foods such as beef, other meats, cooked meats, animal-based foods high in fats, fish and sea foods, but also plant-based products (spices, plant-based foods high in fats, plant-based dishes, prepared desserts) and some beverages (juices, alcoholic beverages). They represent 55.9% of the mean budget share (table 2).
Some of these food groups may not be adequate targets for nutritional goals: for example, fish and seafood or 100% pure fruit and vegetable juices are among the foods recommended in dietary guidelines. This could be a drawback of the environmental taxation scenario.

Tax rate
It varies from 2.82€ for beef, the highest emitting food group, to 0.12€/tCO2/100g of product for prepared desserts, the least emitting group.

GHGE changes
They are reported in table 4. Both scenarios predict a significant decrease in emissions. The first result is that 20% tax scenario (A) induces a higher CO2 reduction than the proportional tax scenario (B). We find respectively a -12.04% and a -10.12% variation in emissions, i.e. 471 vs 396gCO2 per household. Our second result is that a CO2 based tax is efficient also on SO2 and N emissions, since induced reductions in those elements are even higher than CO2 ones. Here again, scenario (A) reaches greater effects than does scenario (B).

Nutritional changes
We record decreases in all nutritional indicators. This is not surprising, as no iso-caloric constraint was imposed. As for GHG emissions, the greater impact proceeds from scenario (A) for most nutritional indicators. Concerning the energy content of purchases, both scenarios predict changes from -10.37% (scenario A) to -9.23% (scenario B). These variations represent about 320 to 284kcal/day per household. Regarding macronutrients, we observe the more important reductions in lipids (-15.7 to -12.76%), then proteins (-10.13 to -8.89%), and carbohydrates (-1.74 to -3.84%). Lipids and proteins register greater impacts with scenario A, while carbohydrates content is more reduced in scenario B.
Among nutrients of interest, recommended to be limited, we can stress an important variation in saturated fats (-17.77 to -13.06%), in cholesterol (-14.77 to -13.06%), and in sodium (-9.28 to -8.32%). Among nutrients which are promoted in dietary recommandations are fibers and iron. Fibers are reduced also, in moderate rate (-4.03 to -4.32%). In that case, the effect induced by scenario A is lower than in scenario B. Iron content registers a strong decrease (-13.15 to -10.36%). Vitamins content supports also important reductions, always higher in scenario A except for vitamin B2.
Regarding most indicators, scenario A has a greater impact. Further discussion on nutrition benefits is quite delicate in our framework since our results proceed from purchases data at the level of the household, while diet quality can only be evaluated upon individual criterions. Moreover, we deal with purchases for food-at-home which do not represent the full consumption. Unfortunately, our data do not include food-away-from home.

	GHG emission/100g of food		Scenario A	Scenario B
Food groups	**Mean**	**Std. Dev.**	**Tax rate in %**	**Tax in €/tCO_2/100g**
Juices	3.74	7.23	20	0.15
Alcoholic beverages	4.59	10.13	20	0.20
Soft drinks	1.72	3.43	0	0
Bottled water	0.97	1.72	0	0
Coffee, Tea	0.80	1.82	0	0
Fresh fruits and vegetables	0.86	2.45	0	0
Spices	12.98	26.86	20	0.63
Plant-based foods high in fats	4.74	9.88	20	0.21
Plant-based dishes	5.73	13.69	20	0.27
Plant-based foods high in sugar	1.74	4.82	0	0
Starchy foods	1.38	3.42	0	0
Processed fruits and vegetables	0.99	2.02	0	0
Beef	56.47	118.95	20	2.82
Other meats	4.16	10.23	20	0.18
Cooked meats	5.80	15.00	20	0.26
Animal-based foods hich in fats	9.04	19.17	20	0.43
Cheese	0.50	1.22	0	0.00
Fish and seafoods	3.80	12.51	20	0.16
Dairy products	0.01	0.06	0	0
Prepared mixed meals	1.35	4.43	0	0
Prepared desserts	3.05	6.71	20	0.12

Table 3. GHG emissions and levels of taxation applied to each food group for scenarios (A) and (B)

		Average Household Purchases Daily Equivalent		Percentage of Quantity Change	
		Baseline levels		Impact of taxation (in %)	
		Mean	Std. Dev	Scenario A	Scenario B
Environmt indicators					
CO2	gCO2eq	3913.82	1313.98	-12.04	-10.12
SO2	gSO2eq	44.62	14.79	-14.86	-11.91
N	gNeq	15.12	4.77	-13.70	-10.90
Nutritional indicators					
Energy	kcal	3081.50	833.16	-10.37	-9.23
Proteins	g	102.64	26.92	-10.13	-8.89
Vegetal Proteins	g	22.68	8.93	-3.92	-5.50
Animal Proteins	g	78.18	21.25	-11.95	-9.88
Carbohydrate	g	267.06	83.09	-1.74	-3.84
Sugar	g	178.26	59.09	-1.22	-3.15
Lipids	g	160.87	41.04	-15.70	-12.76
Saturated fats	g	58.89	15.78	-14.77	-13.06
Monounsat. fats	g	56.73	13.60	-15.42	-12.48
Polyunsat. fats	g	33.93	11.39	-18.09	-13.00
Cholesterol	mg	494.84	143.36	-14.79	-14.32
Alcool	g	23.17	14.17	-20.29	-14.04
Fibers	g	14.78	13.11	-4.03	-4.32
Retinol	microg	851.75	248.49	-15.98	-13.58
Beta-carotene	microg	2269.03	972.56	-5.92	-5.02
Vitamin B1	mg	1.77	0.53	-7.49	-7.31
Vitamin B2	mg	2.42	0.72	-5.49	-6.08
Vitamin B3	mg	19.04	5.94	-10.08	-7.62
Vitamin B5	mg	6.03	1.80	-6.86	-6.82
Vitamin B6	mg	1.78	0.50	-9.09	-7.55
Vitamin B9	microg	265.42	87.90	-9.47	-8.45
Vitamin B12	microg	7.15	1.84	-11.88	-9.94
Vitamin C	mg	183.43	82.60	-13.04	-9.63
Vitamin D	microg	2.50	0.76	-15.38	-13.35
Vitamin E	mg	32.37	10.65	-18.29	-13.07
Calcium	mg	1876.61	565.61	-3.80	-5.03
Iron	mg	18.50	26.88	-13.15	-10.36
Magnesium	mg	443.11	185.35	-5.95	-5.48
Sodium	mg	3868.04	2304.66	-9.28	-8.32
Phosphorus	mg	1802.60	489.59	-7.58	-7.47
Potassium	mg	4004.44	1466.97	-6.06	-5.53

Table 4. Percentage change in purchases content after implementation of scenario (A) and (B)

Comparisons with other studies

We can compare our results of the proportional to emissions tax scenario (our scenario B) with two other studies. We consider only non revenue-neutral scenarios, in Edjabou and Smed's study (their scenarios 1A and 1B), and in Briggs et al.'s study (their scenario A).

The Danish study taxes all foods. According to the 2 carbon costs used, tax rates vary across food groups from 7.10 to 0.05% (for 35€/tCO2) and 20.75 to 0.15% (for 102€/tCO2). The induced reductions in carbon footprint are in a range 307-759 gCO2/d/person. This is probably higher than our 396 gCO2/d/household, but their scope of foods targeted is wider. The induced variations in nutrients are between -5.3 and -2.0% in energy intake, -10.5 and -4.0% in saturated fats, and +0.9 to 0.3% in sugar. We obtain in the French case greater effects in the above reductions and no increase in sugar.

The UK study targets targets roughly the same groups, foods based on animal content (all meats and fish, fats) and coffee drinks. It applies tax rates in a range of 0.24 to 0.003€/100g product (current change of 1.76 to 0.02£/kg), which is logically lower than our computation, since we adopt a higher carbon cost for CO2. Therefore, the nutrient content of the UK diet (including the full consumption) registers less variations than in our study, through smaller reductions in energy intake (-1.4%), saturated fats (-2.8%), cholesterol (-3.2%), or sodium (-1.6%). Fibers content are not impacted. They extend their analysis by simulating health consequences and find that this scenario predicts 7768 deaths delayed or averted in the UK population per year, concluding for health co-benefits.

Finally, in a previous study on the same dataset (Caillavet et al.) we simulated a 20% uniform tax on food groups with most adverse effects on the environment (mainly animal-based products). We found more moderate levels of CO2 reduction (lower than 10%), i.e. 322g per household. The nutritional impacts were in the same range, for example for saturated fats (-12%) or cholesterol (-10%).

Conclusion

There are very few studies on the simulation of a carbon tax applied to foods in the framework of consumer economics. This study allows to consider in the French case the relevance of this instrument through two different options: uniform rate or proportional to emissions rate. Our results concern the variations of GHG emissions and the related variations in the nutritional content of foods.

Our main result is that a uniform tax scenario, set at a 20% rate, induces a greater impact than a proportional to emissions tax scenario, based on a 50€/tCO2 carbon cost. This is observed for CO2 reduction and for nutritional impacts. Such a 20% tax scenario result in a better incentive to consumer choices in an environmental perspective. This could have important policy consequences, since the implementation of a VAT increase appears easier than any other tax regulation.

Our results rely on food-at-home purchases, which underestimates the potential of changes due to food taxation, and could modify the relative range of variations. Further investigation considering the full food consumption would certainly be helpful. Furthermore, extending this framework through a health model could be the next step in order to assess the co-benefits of a taxation policy in a sustainability perspective.

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