Proposition de communication pour les 11es Journées de Recherche en Sciences Sociales - Lyon, 14-15 décembre 2017

Assessing the distributional effects of emission-based carbon taxes on food

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Abstract

Food consumption is a major driver of environmental impacts. This paper designs carbon taxation scenarios on food, including or not subsidies, and assess their distributional, environmental and nutritional effects. Food price elasticities are estimated from an EASI demand system, and distributional effects are estimated on continuous distribution, which enables us to compute several inequality indexes. Our results show that a tax policy may be effective in reducing emissions and that a revenue-neutral scenario including subsidies improves as well nutritional aspects. Concerning distributional effects, taxation introduces a regressive impact on poorer households. Contrary to current expectations, it can be worsened by subsidies targeted at healthier foods.

Keywords: food public policy, taxation, distributional effects, demand system.

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1. Introduction

At the European level, the European Commission engaged for a 40% reduction in GHGE until 2030, and 80% reduction until 2050. The global food system is the 2nd contributor to climate change after the energy sector. It is estimated to contribute to 30% of total Greenhouse gas emissions (GHGE) (WEF, 2010). The meat and dairy sector have been estimated to contribute 57% of agricultural GHGE (Gerber et al. 2013). The demand for proteins and meat is expected to grow at a steady pace in the world due to the increase of population and to the nutritional transition giving preference for animal proteins. The unsustainability of this demand which threatens the planet environmental resources leads to find ways to restrict overconsumption of meat in developed countries. The average European consumption of proteins is at least 150% of Dietary Reference Intakes (Aiking, 2015). As for meat, the nutritional recommendations in several countries set up lower levels than those which are currently consumed (World Cancer Fund, French Nutritional and Health Plan, German nutritional guidelines). Taxation could be an incentive to help consumers modify their diet in a more climate-friendly perspective. Moreover, health could benefit from a more sustainable diet which would lower calories coming from total proteins, and/or give more importance to vegetable relatively to animal proteins.

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 French Ministry of Environment advises a more balanced diet combining nutritional and environmental concerns. Among several goals, it includes meat reduction at the rate of -10% per capita from 2007 to 2030 (ADEME 2014). However, it does not indicate how to obtain this trend. Therefore, protein consumption is a key issue. European countries diets share the same major source of proteins: meat, cereals and milk. However they differ by their respective share: France had in 1999 the highest level of animal proteins in diet (De Boer *et al*., 2006). Reducing animal proteins, with or without substituting by plant-based proteins, is a national environmental goal. Recent literature has argued in favour of the comparative efficiency of taxation compared to other policy instruments (Griffith et al. 2014). Interventions to change the relative prices of foods are likely to be the most effective in changing consumption patterns. This supports a carbon tax increasing the price of meat among other unsustainable products (Wellesley *et al.* 2015). Policy instruments aiming at modifying consumer diet seem crucial.

Incorporating the social cost of carbon into food prices may have several benefits. First, it has an informational virtue, which plays a signaling role for the consumer which is not aware of the emitting potential of his diet, in particular of its meat demand. Wellesley et al's study in 12 countries shows that public understanding of livestock's role in climate change is low. Second, as livestock is by far the most contributor to diet-related GHGE (Gerber *et al.* 2013), a special interest has been developed on the means to restrict meat demand growth and several papers study specifically meat taxation. They find from simulations that a price increase due to a tax proves an efficient tool to redirect consumption towards more favourable climate patterns (Säll and Gren, 2015; Chalmers *et al.*, 2016). Third, it may induce at the same time health benefits. The assessment of combined nutritional and environmental benefits is an important focus in studies examining carbon taxation scenarios on food. These studies simulate different options for taxation, regarding the range of foods targeted, and the tax rate, to address possible nutritional costs of a carbon tax. Briggs *et al.* (2016) simulate 4 scenarios on higher emitting foods and assess both emissions and health impacts. They also combine it with a nutritional tax on sugared drinks. Caillavet *et al.* (2016) in the French case simulate a tax on different sets of high emitting animal-based foods and evidence one scenario where both environmental and nutritional impacts are improved. Finally, an open field of research in food taxation are implementation issues such as the unit of taxation and the tax rate used. Most studies apply a tax rate per weight of product, directly derived from the expression of the carbon cost value. But a functional unit based on a nutritional aspect such as protein content could result more efficient when facing a goal of restricting animal sources of proteins, especially to directly take into account nutrition into an environmental taxation. Emission intensity vary by animal and production system, and designing a tax proportional to emissions takes this into account. However the rate of protein content also varies. Therefore, using as reference unit for taxation the emissions intensity per weight of product or per kg protein has different impacts. Various studies used this latter indicator to compare food items and found that the protein from animal based foods has significantly more impact on the environment than plant-based foods (Reijnders and Soret, 2003; de Boer *et al.* 2006). Among animal-based products, some changes in the relative ranking of GHG emitting potential are observed. According to a FAO study (Gerber *et al.* 2013), beef is the highest emitter regarding both units. However, cattle milk emissions are 4.6% of beef emissions on a CO2/per weight basis, while they represent 28.7% of them on a per kg protein basis.

Taxation raises additional issues, in particular regressivity and conditions of pass-through of the tax by the firms. This latter point will not be addressed here (find some debate in Griffith et al. (2010). Regressivity evidence is found in all taxation studies involving food, since lower income households spend a higher budgetary share on food. At the same time, differences in the composition of their diet and purchase patterns matter for related GHGE and nutritional inequalities, as acknowledged in a French study (Caillavet *et al.* 2016).

The goal of our paper is to design several carbon taxation scenarios on food including or not subsidies and assess their distributional impact, as well as environmental and nutritional incidence. We are concerned here by the continuous distribution, which enables us to compute inequality indexes. We measure taxation impact on environmental emissions and nutrient content through several indicators and a nutritional score. Data proceed from purchases surveys of French households in 2010. We use a previous estimation of an EASI demand system based on food purchases for at-home-consumption (Caillavet *et al.* 2016). We compute pseudo-individual price elasticities and compare two excise tax scenarios. In both cases, proportional rates are implemented according to the level of greenhouse gas emissions of foods. The first scenario increases the price of the higher-emitting food groups which correspond to animal-based foods, and more generally to animal proteins. The second scenario adds to animal-proteins foods taxation, subsidies targeted at plant-based proteins foods in a revenue-neutral framework. The environmental effects are computed using 3 indicators: GHGE, SO2 emissions, nitrates emissions. Nutritional effects are assessed using a nutritional score of diet quality and the ratio of vegetal proteins in total proteins. Finally, we measure the distributional effects through the Gini, Theil and Kakwani indexes.

The remainder of this article is organized as follows. Section 2 presents the data and the methods. Section 3 presents the outcomes of our simulated tax scenarios. Section 4 discusses the results. The last section concludes.

2. Material and Methods

2.1. 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. Baseline purchases are computed from scanner data with household observations from 2010. Following Caillavet *et al* (2016) we kept the households for which the entire food purchases are registered giving a sample of 7,134 households.

Environmental data are collected by Greenext, an environment consultancy, which assigns the environmental impact of 311 food products through a hybrid method. The methodology is based on Life-Cycle Analysis LCA), using ISO14040-44 standards including each life-cycle stage (production, transformation, distribution, use and end-of-life) of food products. The data used for each step of product life cycle is a mix of data derived from a bottom-up LCA method and a top-down Input-Output approach (Bertolucci *et al.* 2016). 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) CO_2 gives the Carbonic dioxide emissions (in grams of CO_2 equivalent per 100 g), which relates to the impact on climate change, namely, GHGE; (2) SO_2 gives the Sulfur dioxide emissions (in grams of SO_2 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 3067kcal/day per household. Apart from energy intake, a set of 15 nutritional indicators is computed and allows to assess a nutritional score, the Mean Adequacy Ratio to nutritional guidelines (MAR, see Darmon *et al.* 2014).

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.

2.2. Simulation scenarios

The impact of each scenario is assessed 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

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

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. Using previously published approach (Caillavet *et al.* 2016), nutritional and environmental elasticities are computed at the individual level of purchases.

2.2.1. Choice of the foods targeted

All food groups are GHG emitters. Table 1describes the average values of CO2eq expressed per 100g for food. Several approaches may be considered and have been used in the literature.

Food Groups	Emission per in grams per 100g	Average price increase of Emission in euros per kg	Daily food expenditure in euros	Quantity of each food group in kg	Emissions based on effective purchases	Ratio vegetal proteins from total proteins
Juices	70.59	0.10	0.21	0.20	185.16	1.00
Alcohol	175.82	0.25	0.84	0.26	417.09	1.00
Soft drinks	62.74	0.09	0.21	0.27	132.10	1.00
Bottled watter	26.09	0.04	0.19	0.79	197.90	0.00
Coffee and tea	36.14	0.05	0.26	0.04	13.14	0.92
Fresh fruits and vegetables	129.23	0.18	1.27	0.75	819.01	0.90
Spices	245.26	0.34	0.05	0.02	36.58	1.00
Plant-based foods. high in fats	181.43	0.25	0.12	0.04	62.24	1.00
Plant-based dishes	141.74	0.20	0.11	0.02	37.55	0.60
Plant-based foods. high in sugar	194.22	0.27	0.61	0.12	134.11	0.85
Starchy foods	195.81	0.27	0.37	0.20	208.93	0.97
Processed fruits and vegetables	223.67	0.31	0.54	0.17	257.86	0.84
Beef	1387.10	1.94	0.60	0.05	813.95	0.04
Other meats	817.08	1.14	0.95	0.15	424.38	0.00
Cooked meats	562.92	0.79	0.67	0.08	404.34	0.00
Animal-based foods. high in fats	620.73	0.87	0.26	0.07	399.54	0.00
Cheese	454.48	0.64	0.87	0.14	145.86	0.00
Fish and Seafood	380.27	0.53	0.57	0.05	147.48	0.00
Dairy products	159.55	0.22	0.69	0.57	4.78	0.01
Prepared mixed meals	390.23	0.55	0.64	0.11	211.30	0.31
Prepared desserts	273.37	0.38	0.79	0.20	582.64	0.62

Table 1 Emissions by food groups (daily basis)

Incorporating the social cost of carbon into food induces to simulate an increase in all foods, on the basis of the amount of emissions (as in Edjabou and Smed 2013). *High emitting foods* may be the target for an environmental tax. The choice of the foods targeted (see Table Table 2) may be fixed on the average level of emissions, i.e. by applying a GHGE tax to each food group with emissions over that threshold (as in Briggs *et al.* 2013, 2016).

	Budget	Environment			Nutrition		
		SO2	CO2	N	Energy	Veg prot	Ani prot
Beef	*5.1*	*22.9*	*13.3*	*9.8*	*2.1*	*1.3*	*9.9*
Other meats	*8.7*	*13.6*	*7.4*	*15.0*	*4.9*	*0.1*	*20.4*
Cooked meats	*6.3*	*11.9*	*7.3*	*13.2*	*3.3*	*0.0*	*11.3*
Cheese	*8.1*	*4.0*	*2.7*	*1.2*	*9.4*	*0.0*	*22.7*
TAX	**28.2**	**52.4**	**30.7**	**39.1**	**19.7**	**1.4**	**64.3**
Fresh fruit & veg	*11.2*	*6.4*	*14.2*	*10.1*	*5.9*	*15.3*	*0.2*
Starchy foods	*3.6*	*2.1*	*3.9*	*3.7*	*9.3*	*28.9*	*0.3*
TAX-SUB	**42.9**	**60.8**	**48.8**	**53.0**	**34.9**	**45.6**	**64.8**

Table 2: Targeted food groups in French food at home (%)

2.2.2. Choice of the tax rates

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, and an ongoing debate on methods and results, which is out the scope of this work (Van den Bergh and Botzen 2015). Quinet's report (2009), on the basis of the European Commission's goals, recommended values of 32€ in 2010, 56€ in 2020, 100€ in 2030, 200€/tCO2 in 2050.

In studies where carbon tax is applied to food, rates have been set up to different levels. Revell (2015) at the world level used US$ 80/t. Brigg's et al. in the UK case applied 2.86£/tCO2eq/100g (27.19£/tCO2eq/kg in 2013). Edjabou and Smed tested two prices: 0.26 and 0.76 DKK/kgCO2.

For our evaluation, we take an average rate of 140€/tCO2 announced in July 2017 in France to reach the European commitment. We will assume here that prices at the consumer level incorporate an extra-cost of 140€/tCO2 neglecting producers and retailers pricing strategies.

2.2.3. Scenarios

We incorporate the social cost of carbon to foods by comparing: emissions/100g and emissions/per 100g of animal proteins and the subsequent emission-based tax rates. As basis to compute the level of taxation, we consider an extra cost of €15/tCO_2e/100g of food. Based on this value, we measured the effects of two scenarios:

- **Taxation simulations:**
    - Proportional rates (***scenario PROP***) according to the level of greenhouse gas emissions of foods, carbon social cost of 140€/ton (French Ministry, 6th july 2017).
    - ***Scenario TAX : taxes only*** on the higher-emitting food groups rich in animal proteins (beef, other meats, cooked meats, cheese).
    - ***Scenario TAX-SUB*** *:* ***revenue-neutral*** scenario, using scenario TAX revenue to ***subsidise*** foods rich in plant-based proteins (fresh fruits and vegetables, starchy foods).

3. Results : outcomes of the fiscal policy

3.1. Tax rates

According to our computations, the mean level of emission across food groups amounts to 2.14 kgCO2/100g. The most emitting food groups (above this emission level) include mainly 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). The highest extra-costs are found for beef, spices and animal-based foods high in fats. The lowest ones concern dairy products other than cheese, cheese, fruits and vegetables. Consequently the average tax rates tax rates vary from 0.58% to 22.49%.

3.2. GHGE changes

They are reported in Figure 1. Both scenarios predict a significant decrease in emissions. In the scenario PROP concerning all foods, variations in environmental indicators are moderate: -16.96% for SO2, -15.17% for CO2, -14,75% for N. In the scenario TAX targeted mainly animal protein-based foods, we observe much lower reductions: -9.01% for SO2, -6.42% for N, -5,23% for CO2. In both cases, the CO2 indicator, though the main indicator used in the literature, does not register the highest variation. In the scenario TAX-SUB adding a subvention to fresh fruits and vegetables, starchy foods further nuances the effects on the environment: -7.68% for SO2, -4,29% for N, -2.40% for CO2. In both cases, the CO2 indicator, though the main indicator used in the literature, does not register the highest variation.

3.3. Nutritional changes

Three nutritional indicators are summarized in Figure 2. First, the Mean Adequacy Ratio (hereafter MAR) illustrates the suitability for nutritional recommendations. The more likely it is to reach 100, the better the household diet. Second, protein's share of total calories (ratio protein cal/tot cal) measures the impact of protein substitutions following taxation. Third, the plant-based share of total proteins measures the animal proteins by plant-based proteins.

In scenario PROP, the MAR to nutritional guidelines improves very slightly (84,33 vs 84.91 at baseline).[2] Taxing only the animal base products (scenario TAX) (i.e. 19.7 % of energy intake) degrades the nutritional quality of the diet compared to the baseline. To summarize, an improvement of diet quality only in TAX-SUB (revenue-neutral) is observed. It is explained by an increase of MAR (+0,3%), higher ratio of vegetal proteins (+2,5%).

Finally, an improvement of diet quality in TAX-SUB (revenue-neutral) is observed. It is explained by an increase of MAR (+0,3%), higher ratio of vegetal proteins (+2,5%).

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[2] Detailed results are available upon request.

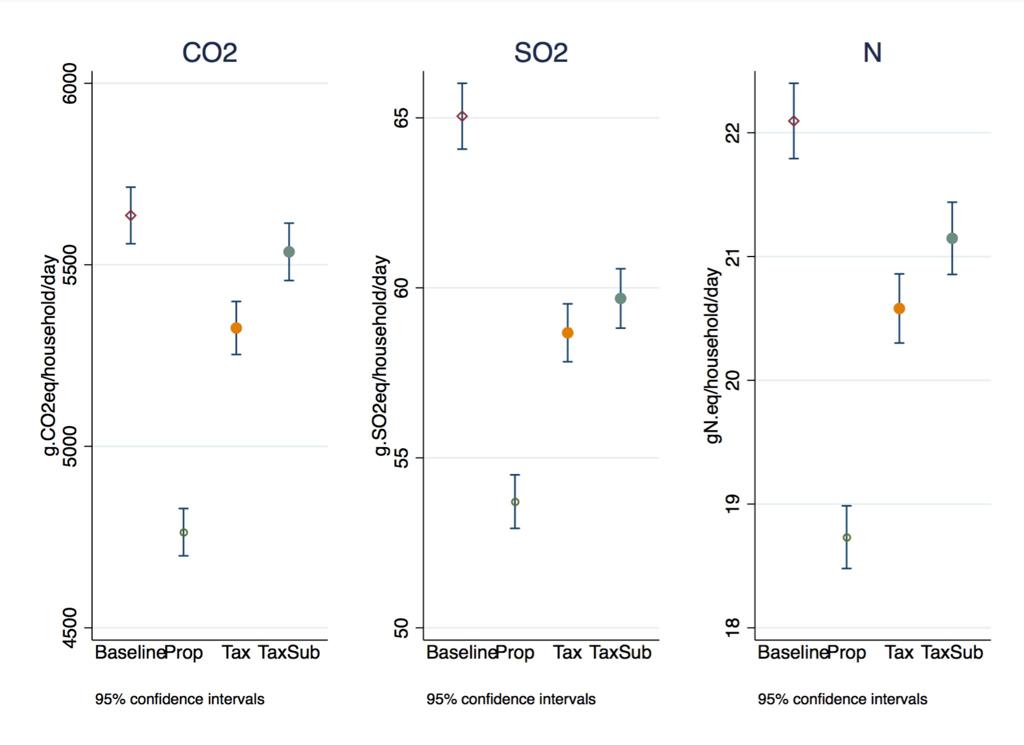

Figure 1: Environmental values for respectively: CO2, SO2 and N, and by scenario. (Average values and 95% confidence intervals.)

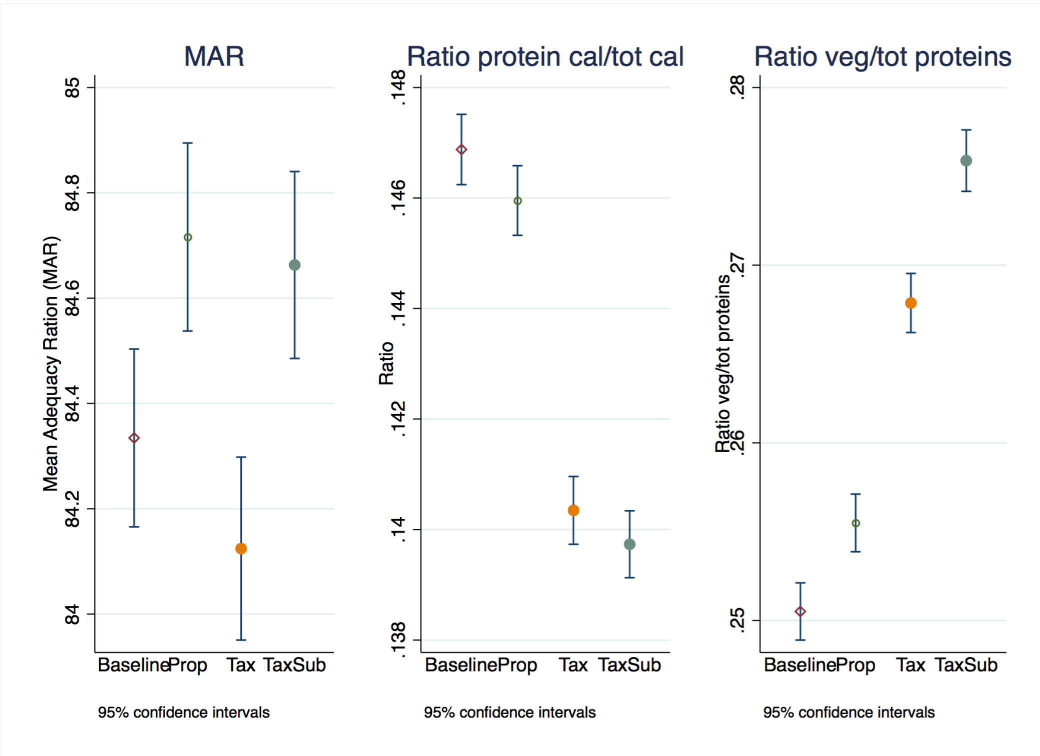

Figure 2: Nutritional values for respectively: MAR, protein's share of total calories, and plant-based share of total proteins by scenario. (Average values and 95% confidence intervals (2000kcal basis).

3.4. Distributional effects

Regressive effect in both scenarios, worse when subsidizing healthy foods, confirmed by the increase of each inequality indexes**.** Our results include two main contributions. First, they enable to compare the effects of taxation scenarios including or not subsidies. With a carbon cost of 140€/ton, recently set up by the French Ministry (officially announced on 6th July, 2017) taxation rates are in a range of 9% to 19% for high-emitting foods, such as animal proteins foods. Reductions induced in environmental emissions are moderate, 5% to 9%. Nutritional effects show a slight decrease of the diet quality score.

Our second scenario, in which subsidies on vegetal proteins foods are introduced using taxation revenue, still reduces but does not improve the emissions mitigation. However, nutritional indicators are quite favourable, since the diet quality score improves (+0.3%) and in particular the share of vegetal proteins increases + 2.5%.

Finally, we can compare the equity content of our food policies by computing Gini indices of expenditure in the pre-reform and the post-reform scenarios, as well as the Theil and Kakwani indexes (see Figure 3 and Table 3). The regressive impact of the taxation scenario is confirmed, as expected. But surprisingly the scenario including subsidies does not alleviate this regressive impact. It shows that the choice of targeting healthy foods such as fresh fruits and vegetables for subsidies can result in increasing consumption inequalities.

Our results show that a food tax policy may be effective in reducing emissions. Adding subsidies on healthy foods improves nutritional indicators. However distributional effects, measured through individual measures, remain a key issue, not easily solved with the food subsidies tool. Further implications should be carefully designed to target poorer households.

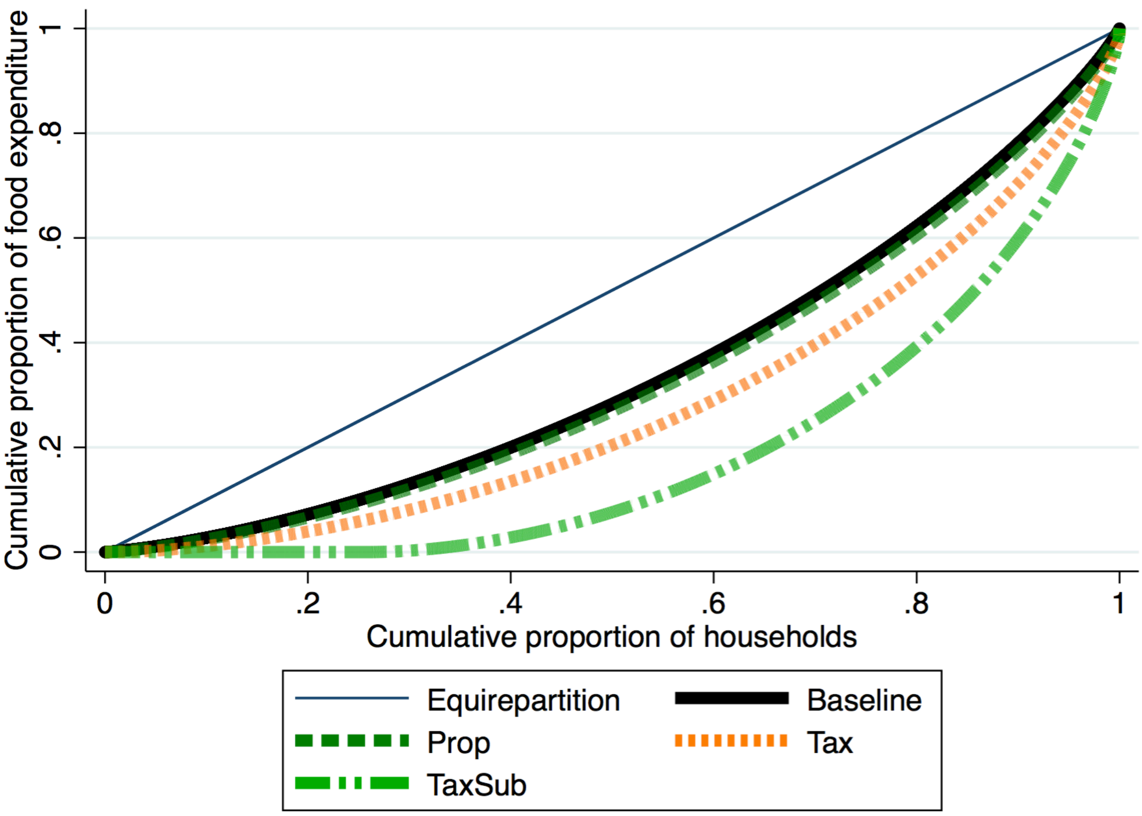

Figure 3: Lorenz curves at the baseline and by scenario

Inequality indexes	Baseline	PROP	TAX	TAX-SUB
Gini	0.308	0.329	0.430	0.613
Theil (a=1)	0.152	0.176	0.335	0.408
Kakwani	0.085	0.097	0.160	0.316

Table 3 Inequality indexes by scenario

4. Conclusion

There are still few studies on the evaluation of a carbon tax applied to foods in the framework of consumer economics. This study allows considering in the French case the relevance of this instrument for GHGE mitigation. It addresses several important methodological issues. Retaining the carbon cost of 140€/t, we design a proportional to emissions tax, which allows to discriminate foods according to their environmental impact. In search of taxation efficiency, we use two different functional units for taxation: the usual GHG emissions per weight of food, and the nutritional unit of GHG emissions per animal protein content. Thus the tax rates induced and the food groups targeted are different.

Our results concern several dimensions: the variations of GHG emissions, the related changes in the nutritional content of purchases, and the eventual substitutions between different sources of protein, animal and plant-based. Concerning the first dimension, taxation according to the emissions potential of the animal protein reaches a higher reduction of GHGE than on a per weight basis. Moreover, nutritional adequacy to guidelines is overall maintained. However animal protein replacement by vegetal proteins is not achieved by such taxation policies.

Our estimations rely on food-at-home purchases, which underestimate 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, more estimations taking into account household heterogeneity in income, could provide different substitution patterns and moderating conclusions. It could be the next step in order to assess the relevance of a carbon tax on food in a sustainability perspective.

References

ADEME (2014). Alléger l'empreinte environnementale de la consommation des Français en 2030. http://www.ademe.fr/sites/default/files/assets/documents/ademe-alleger-empreinte-environnement-2030_rapport_28112014.pdf

Bertolucci G., Masset G., Gomy C. and Mottet J., Darmon N. 2016. How to build a standardized country-specific environmental food database for nutritional epidemiological studies. *Plos One (forthcoming)*

Briggs, A. D., Kehlbacher, A., Tiffin, R., Garnett, T., Rayner, M. and Scarborough, P. (2013). Assessing the impact on chronic disease of incorporating the societal cost of greenhouse gases into the price of food: an econometric and comparative risk assessment modelling study. *BMJ open* 3: e003543.

Briggs, A. D., Kehlbacher, A., Tiffin, R., Garnett, T., and Scarborough, P. (2016). Simulating the impact on health of internalizing the cost of carbon in food prices combined with a tax on sugar-sweetened beverages. *BMC Public Health* 16:107 DOI 10.1186/S12889-016-2723-8.

Caillavet F., Fadhuile A., and Nichèle V. (2016). Taxing Animal Products for Sustainability: Environmental, Nutritional and Social Perspectives in France. *European Review of Agricultural Economics* doi:10.1093/erae/jbv041.

Chalmer N.G., Revoredo-Giha C. and Shackley S. (2016). Socioeconomic effect of reducing household carbon footprints through meat consumption, *Journal of Food Products Marketing,* DOI: 10.1080/10454446.2015.1048024.

Darmon N., Lacroix A., Muller L. and Ruffieux B. (2014). Food price policies improve diet quality while increasing socioeconomic inequalities in Nutrition. *International Journal of Behavioral Nutrition and Physical Activity* 11: 66.

De Boer, Helms M. and Aiking A. (2006). Protein consumption and sustainability: Diet diversity in EU-15. *Ecological Economics* 59:267-274.

Edjabou, L. D. and Smed, S. (2013). The effect of using consumption taxes on foods to promote climate friendly diets: the case of Denmark. *Food Policy* 39:84-96.

Gerber P.J., Steinfeld H., Henderson B., Mottet A., Opio C., Dijkman J., Falcucci A. and Tempio G. (2013). *Tackling Climate Change Through Livestock: A Global Assessment of Emissions and Mitigation Opportunities.* Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Gonzalez A. D., Frostell B. and Carlsson-Kanyama A. (2011). Proteins efficiency per unit greenhouse gas emissions: Potential contribution of diet choices to climate change mitigation. *Food Policy* 36: 562-570.

Griffith R. and O' Connell M. (2010). Public policy towards food consumption. Fiscal Studies 31(4): 484-507.

Masset G., Soler L.-G., Vieux F., Darmon N. (2014). Identifying sustainable foods: relationship between environmental impact, nutritional quality and prices of foods representative of the French diet. *Journal of the Academy of Nutrition and Dietetics* 114 (6): 862-869.

Quinet A. (2009). La valeur tutélaire du carbone. Rapports et Documents n°16. La documentation française.

Reijnders L. and Soret S. (2003). Quantification of the environmental impact of different dietary protein choices. *American Journal of Clinical Nutrition* 78(suppl): 664S-668S

Revell B. 2015. Meat and milk consumption 2050: the potential for demand-side solutions to GHGE reduction. *Eurochoices* 14(3) DOI : 10.1111/1746-692X.12103

Säll S. and Gren I-M. (2015). Effects of an environmental tax on meat and dairy consumption in Sweden. Food Policy 55: 41-53.

Scarborough P., Appleby P.N., Mizdrak A., Briggs A.D., Travis R.C., Bradbury K.E., and Key T.J. (2014). Dietary greenhouse gas emissions of meat-eaters. fish-eaters. vegetarians and vegans in the UK. *Climatic Change* 123. 179-92.

Thow, A. M., Jan, S., Leeder, S. and Swinburn, B. (2010). The effect of fiscal policy on diet, obesity and chronic disease: a systematic review. *Bulletin of the World Health Organization* 88: 609-614.

Van den Bergh J.C.J.M., and Botzen W.J.W. (2015). Monetary valuation of the social cost of CO2 emissions: a critical survey. *Ecological Economics* 114: 33-46.

Vieux F., Darmon N., Touazi D. and Soler L.-G. (2012). Greenhouse gaz emissions of self-selected individual diets in France: changing the diet structure or consuming less? *Ecological Economics* 75: 91-101.

WEF (2010). Realising a New Vision for Agriculture: A Roadmap for Stakeholders. Geneva: World Economic Forum.

Wellesley L., Happer C., Froggatt A. (2015). Changing climate, changing diets. Chatham House Report. November 2015.

Wirsenius, S., Hedenus, F. and Mohlin, K. (2011). Greenhouse gas taxes on animal food products: rationale,tax scheme and climate mitigation e↵ects. Climatic Change 108: 159–184.