PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (see an example) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

ARTICLE DETAILS

TITLE (PROVISIONAL)	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
AUTHORS	Briggs, Adam; Kehlbacher, Ariane; Tiffin, Richard; Garnett, Tara; Rayner, Mike; Scarborough, Peter

VERSION 1 - REVIEW

REVIEWER	Louis-Georges Soler Research Unit INRA-Aliss 1303 Institut National de la Recherche Agronomique, France
REVIEW RETURNED	02-Aug-2013

GENERAL COMMENTS	In this paper, the authors model the effect of a UK GHG emission food tax on health. Two scenarios are modeled: in the first scenario, food groups with GHG emissions greater than average are taxed; in the second scenario, high in GHG emissions food groups are taxed and those with low emissions are subsidized in a revenue-neutral framework. The authors use two models: - An economic model which is used to assess the consumption variations induced by the tax policy. This economic model relies on a demand system analysis already published by some of the authors. From this previous research, they get the direct and cross-price elasticities needed to calculate the consumption changes induced by the changes in prices. - A health model to assess the public health effects of the consumption variations generated by the tax policy. This health model has also been already published in another journal. It is based on the relative risks estimated for different diseases and related to nutrient intakes variations. Combining these two models, the authors propose a relevant analysis whose main originality is to combine health and environmental evaluations. The main results are the following: - When the tax policy is used to increase the price of the high in GHG emission food groups, the reduction is the GHG emissions is around 7.5% and 6751 deaths can be delayed or avoided. This health result is mainly due to the reduction in the average energy intake (-1%). - When the tax is combined with subsidies, the environmental impact is smaller and one observes an increase in the

number of deaths due to an increase in the energy intake.

Then, internalizing the costs of GHG emissions in the food system has the potential to reduce GHG emissions and save lives, but only in the first scenario. In the second scenario, when low in GHG emission products are subsidized, the consumption of energy-dense products increases leading to an increase in the average calorie intake.

The paper is clear and well-written. The data and the methods are well presented. The results are interesting and clearly presented and their limits are well discussed.

However, some points could be better explained:

- The perimeter on which the GHG data are estimated is not completely clear for me. The authors say that they use the GHG emissions from the primary production up to the retail distribution centre (pre-RDC) and land-use change, and not emissions from processing, distribution, retail, and preparation (post-RDC). But, if I well understand, at the RDC, the products come from the manufacturers and then have been are already processed and packaged (and transported from the farm to the storing platform or to the store). Are these activities taken into account? Do the authors mean, in fact, that they do not take into account the emissions at the store level, the transportation from the store to the consumers, and preparation, processing and waste at-home?
- Still about the data, the authors do not explain how the GHG emissions are calculated for the milk/beef meat products. The repartition of the GHG emissions between milk and beef products is always complicated and relies often on arbitrary rules which it is worth to explicit. Moreover, it is very country-dependent and deeply influenced by the production processes the most used at the farm level in the country. I ask this question because it can have important consequences on the results of scenario (b) (see below).

- The authors use households' purchases data to compute the variations of individual nutrients intakes induced by the price policies. No problem for me, but we know that is often very complicated to get consistent results when we compare households' purchase datasets and individual consumption datasets. The gap is not only due to at-home waste or the presence of children in the households, but more generally to the difficulty to share the purchases among the members of the households in order to get consistent values of individual consumption. Some methods have been proposed to deal with this issue. I do not ask the authors to develop this point, but maybe to insist a little more on the uncertainty induced by the use of purchases data.

- Could the authors explain a little more how they proceeded in Scenario (b) to get the neutral revenue equilibrium (iterative process)?

- Could the authors tell how much the 6751 deaths delayed or averted in scenario (a) represent in terms of reduction of the total mortality in the UK (around 1% ?)? Significant variation compared to the benchmark (no tax)?

	- The impacts of Scenario (b) on the GHG emissions are surprising. We would expect a greater impact as tax and subsidies are used. It is due to product substitutions, especially with milky products (and beer? By the way, what about the health effects of variations in alcoholic beverages consumption?). As mentioned above, the GHG emissions related to beef meat and milk are often disputable and complex to determine. I think it is important that the authors explain a little more how the emissions values of meat and milk are estimated in order to reinforce the robustness of the results (in the complementary file?) and discuss their sensitivity in relation to the methods used to assess the GHG emissions of milk and beef meat. - The policies are based on two instruments: the tax rate (£2.72) and the threshold (0.41kgCO2/100g) according to which the products are, or not, taxed. Could the authors give some comments about the sensitivity of the results in relation with these values? Indeed, we could imagine alternative policies combining differently these two instruments: high tax rate-high threshold; low tax-rate- low threshold, etc… Would the results be strongly modified? If the authors do not have the answer yet, they can suggest this point as a next step to investigate. - An important result is that environmental and health issues are not necessarily aligned. This point has been already identified in papers based on other data and methods (Vieux et al., 2012, Ecological Economics; Vieux et al., AJCN, 2013). It would be interesting to insist on this point because it is clearly an important challenge in the future for researchers and policy makers. In conclusion, I think that the paper must be accepted. Nevertheless, I suggest a few improvements to make clearer the points mentioned above.

REVIEWER	Dr. Kuishuang Feng Research Assistant Professor University of Maryland College Park United States No conflicts of Interests
REVIEW RETURNED	23-Aug-2013

GENERAL COMMENTS	This study estimated the impacts of a UK GHG emission food tax on emission reduction and health. The study found that the GHG emission food tax may reduce GHG emissions but also substantially improve population health. However, there is still potential risk on health when subsidizing food products that have low GHG emissions. There are only very few studies to investigate the emission taxation on food products and related health issue. Thus, the study is interesting and timely important. See some minor suggestions below. 1) There are five steps to model the impact of GHG taxation. A figure on modeling framework of this study would help audiences to better understand the methods and the connections of different steps. 2) In discussion section, it might be worth to mention that increasing in food price might impose more burdens on the low income groups

	than rich. Thus, part of the revenue generated from GHG taxation should be used to compensate the low income group.

VERSION 1 – AUTHOR RESPONSE

Many thanks for your comments.
Alongside specifically addressing individual comments (see below) we have made some other changes to the original manuscript. These are following the identification of a small error in the computation of unconditional elasticity values (the matrix of expenditure shares was not transposed). We have therefore recomputed the unconditional elasticities and repeated the modelling of the effect of the tax on mortality, greenhouse gas emissions, and revenue.
The effects on the magnitude and direction of the results for both taxation scenarios on deaths averted, change in greenhouse gas emissions, and revenue generated are minimal. Therefore, the discussion and the conclusions of the paper have not changed.

Reviewer: Louis-Georges Soler
Comment 1. The perimeter on which the GHG data are estimated is not completely clear for me. The authors say that they use the GHG emissions from the primary production up to the retail distribution centre (pre-RDC) and land-use change, and not emissions from processing, distribution, retail, and preparation (post-RDC). But, if I well understand, at the RDC, the products come from the manufacturers and then have been are already processed and packaged (and transported from the farm to the storing platform or to the store). Are these activities taken into account? Do the authors mean, in fact, that they do not take into account the emissions at the store level, the transportation from the store to the consumers, and preparation, processing and waste at-home?

Response 1. This is an important point that you have raised. The original method that greenhouse gas emissions have been derived for individual food groups use in Audsley et al. 2009 (from which the greenhouse gas emissions are taken) varies in terms of where production ends and processing begins. Pragmatically, Audsley et al. use the RDC as their cut off point although this exact point varies slightly from food group to food group. Despite being discussed in the reference associated with this point, we appreciate that this is not entirely clear in our paper. We have therefore added a sentence outlining this and explicitly pointing readers to the Audsley et al. reference.

Comment 2. Still about the data, the authors do not explain how the GHG emissions are calculated for the milk/beef meat products. The repartition of the GHG emissions between milk and beef products is always complicated and relies often on arbitrary rules which it is worth to explicit. Moreover, it is very country-dependent and deeply influenced by the production processes the most used at the farm level in the country. I ask this question because it can have important consequences on the results of scenario (b) (see below).

Response 2. The values for GHG emissions relating to beef and milk are specific to England and Wales and taken from the Cranfield University report to Defra on project IS0205. The model used assumes:
“that 35% of beef calves originate from beef suckler herds. Of these suckler herds 33% and 33% are located in the hills and uplands respectively with 40% of the remaining lowland herds calving in the spring. Of the spring born non-organic lowland suckler calves 20% and 20% are assumed to be finished intensively as cereal beef and silage beef, respectively. Of the dairy bred calves 45% are finished in 18-20 months, 25% in 22-24 months and 15% are winter finished. 0.76% of the market is assumed to be currently organic.
Milk is modelled as self-contained herds at a series of yield levels. In the non-organic case, three yield levels are modelled for autumn and for spring calving herds. In the organic herds, we model three yield levels and an all year round calving pattern.

The model assumes that 1% of the market is currently organic. For each of the series of yield levels 25% are low, 55% are medium yielding and the balance are the highest yielding. Of the non-organic herds 80% are autumn calving and 20% of the herds have access to maize silage in their diets."
We are aware that emissions from milk and beef will vary markedly between different countries and between different farms (Diary Roadmap 2013, http://www.dairyco.org.uk/resources-library/research-development/environment/dairy-roadmap-2013/), and that calculations will depend on various cut off points. For example, there is one small difference between GHG emissions for milk between the How Low Can We Go report and the cited Cranfield report in that HLCWG includes pasteurisation in its pre-RDC emissions. We feel that the level of detail presented in the Cranfield report is too complex for the general readership of the BMJ Open – however we have added to following to the limitations in the discussion which includes a direct reference to the Cranfield report:
"Furthermore, the uncertainties surrounding the estimations of GHG emissions are not modelled; these will vary between different food products and between different producers with some (such as milk and beef)46 having greater uncertainty than others.38"

Comment 3. The authors use households' purchases data to compute the variations of individual nutrients intakes induced by the price policies. No problem for me, but we know that is often very complicated to get consistent results when we compare households' purchase datasets and individual consumption datasets. The gap is not only due to at-home waste or the presence of children in the households, but more generally to the difficulty to share the purchases among the members of the households in order to get consistent values of individual consumption. Some methods have been proposed to deal with this issue. I do not ask the authors to develop this point, but maybe to insist a little more on the uncertainty induced by the use of purchases data.

Response 3. We have added in our strengths and limitations that our uncertainty estimates are conservative and that there may be differential responses to the tax by age in terms of both purchasing and waste.

Comment 4. Could the authors explain a little more how they proceeded in Scenario (b) to get the neutral revenue equilibrium (iterative process)?

Response 4. We have added the following paragraph to step 1 of the methods section:
"The rate of subsidy in scenario (b) was calculated by applying the tax rate of £2.72 tCO2e/100g product to the difference between the mean GHG emissions (0.41 kgCO2e/100g) and the GHG emissions for each food group with emissions below average."
As the tax rate is based on the mean emissions for 100g of food eaten in the UK, if the scenario does not affect consumption patterns then the total amount of emissions above this mean, and therefore the revenue, will equal the total amount below, the subsidy. Of course, in the scenario consumption patterns are changed, which means that the scenario is not strictly (but is approximately) revenue neutral.

Comment 5. Could the authors tell how much the 6751 deaths delayed or averted in scenario (a) represent in terms of reduction of the total mortality in the UK (around 1% ?)? Significant variation compared to the benchmark (no tax)?

Response 5. Already included at the beginning of the discussion is the reduction in terms of total mortality in the UK (about 1.4% with the newly modelled results) which we agree adds a wider context to the presented results.

Comment 6. The impacts of Scenario (b) on the GHG emissions are surprising. We would expect a greater impact as tax and subsidies are used. It is due to product substitutions, especially with milky products (and beer? By the way, what about the health effects of variations in alcoholic beverages consumption?). As mentioned above, the GHG emissions related to beef meat and milk are often disputable and complex to determine. I think it is important that the authors explain a little more how the emissions values of meat and milk are estimated in order to reinforce the robustness of the results (in the complementary file?) and discuss their sensitivity in relation to the methods used to assess the GHG emissions of milk and beef meat.

Response 6. We have included in our model the change in population mortality as a result of changes in alcohol consumption (see table 4).
See response 2 for added section to discussion limitations.

Comment 7. The policies are based on two instruments: the tax rate (£2.72) and the threshold (0.41kgCO2/100g) according to which the products are, or not, taxed. Could the authors give some comments about the sensitivity of the results in relation with these values? Indeed, we could imagine alternative policies combining differently these two instruments: high tax rate-high threshold; low tax-rate- low threshold, etc… Would the results be strongly modified? If the authors do not have the answer yet, they can suggest this point as a next step to investigate.

Response 7. We would hypothesise that changing tax rates and thresholds would lead to changes as expected by the degree of tax rate but without doing the extra modelling, the exact results are not known. We have added at the end of our discussion that this is potential next step.
“Alongside this work, there should be greater exploration of the effects of different tax rates and models to explore whether the synergies and conflicts identified in this research may be negated or reversed.”

Comment 8. An important result is that environmental and health issues are not necessarily aligned. This point has been already identified in papers based on other data and methods (Vieux et al., 2012, Ecological Economics; Vieux et al., AJCN, 2013). It would be interesting to insist on this point because it is clearly an important challenge in the future for researchers and policy makers.

Response 8. This is one of the main messages of this paper and forms parts of the conclusions in the abstract, the key messages in the article summary, and is mentioned at the beginning of paragraph 2 of the discussion. We have included this again at the end of the discussion under implications for future research.
We have not directly compare our work to that of Vieux et al. as they compare existing diets rather than using mechanisms to change diets based on major emitting food groups. Furthermore, the diets investigated by Vieux et al. have broadly similar amounts of meat and dairy (the major emitters) with high and low quality diets swapping fruit and veg consumption with carbohydrate – our work instead results in significant changes to meat consumption (alongside some shifts in sugar and fruit and veg).

Reviewer: Dr. Kuishuang Feng
Research Assistant Professor
University of Maryland College Park
United States

Comment 1) There are five steps to model the impact of GHG taxation. A figure on modeling framework of this study would help audiences to better understand the methods and the connections of different steps.

Response 1) We have now included such a figure as figure 1.

Comment 2) In discussion section, it might be worth to mention that increasing in food price might impose more burdens on the low income groups than rich. Thus, part of the revenue generated from GHG taxation should be used to compensate the low income group.

Response 2) We have mentioned the likely regressive nature of this tax in our discussion under Implications and Future Research. Rather than suggesting compensation to low income groups, we prefer suggesting that research should investigate this in more detail as although likely, without using income group specific elasticities the exact economic burden placed on high and low income families remains uncertain.