INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS
ICAE
29th | Milan Italy 2015
UNIVERSITÀ DEGLI STUDI DI MILANO AUGUST 8 - 14
AGRICULTURE IN AN INTERCONNECTED WORLD

Who emits most ?

The environmental impact of food purchases of French households

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15 june 2015

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Acknowledgements:
We thank C. Boizot-Szantaï and N. Guinet (INRA-ALISS, UR 1303) for their help on obtaining Kantar data.
Financial Support:
This work was supported in part by the French National Research Agency under the OCAD project ("Offer and consume a sustainable diet") and by FERRERO.

Abstract

The environmental impact of food is a major concern for climate change. This paper estimates the CO_2 emissions due to food purchases of French households and analyses the disparities between income classes. To combine environment with health concerns, we consider as well the caloric content of foods and normalize CO2 emissions on a daily 2000kcalories basis. Data on French food purchases come from Kantar 1998-2010. Using Life-Cycle-Analysis from Greenext, we obtain CO2equivalent emissions for different food groups. Then we adjust levels of emissions by linear regression on income and age. We find that CO2 emissions of food purchases amount to 3.9kg/day/household. Lowest-income households emit more CO2 compared to richest households (+14.7%), but less on an adjusted 2000kcal basis (-9.6%). In a public policy perspective, richer households should be the first target of diet change since their consumption favours higher CO2 emitting food groups than lower-income households, at caloric level constant.

Keywords: CO2 emissions, Food purchases, Income disparities.

JEL codes: Q56, Q18, Q58

Introduction

The environmental footprint of consumption is commonly associated with the stage of economic growth. In the environmental literature, the relationship between level of income per capita and environmental footprint is assumed to show an inverted U-shape: this is the Environmental Kuznets Curve hypothesis, following the work of Grossman and Krueger (1995). This relation has been used to describe the development of a single economy on the long-term (Lindmark 2002, Egli 2004), and has also been tested among countries with different levels of income. The results obtained are controversial. For example, on richer countries like OECD ones, an inverted U-shape is found, but not on the poorer non-OECD countries, which show an increasing pattern (Galeotti et al. 2006). More rarely, it has been tested with micro data, for example in the case of UK (Giovanis 2013). He finds mixed results, the evidence of an EKC depending on the environmental indicator and the econometric model used. Finally, it has been studied also for specific fields of consumption, such as transport emissions (Cox et al. 2012). Still, at the individual level, little is known about how air pollution varies with income. Besides, whatever the form of the relationship and its conformity with the EKC hypothesis, taking into account the inequality content of environmental footprint may be important at the moment of designing sustainable policies aimed at reducing GHG emissions.

In the French context, Combet et al. (2010) raised the question of equity in assessing the environmental footprint and the consequent taxation issue. Several works show the variability of emissions according to socioeconomic characteristics of the household. The French shopping basket was estimated in 2009 to emit 1.4t equivalent CO2 per year for one household (Boeglin et al. (2012). The variability of this figure according to occupation, family structure, or region was found to reach 20% deviation compared to the average value. In particular, blue-collars, or families with at least 3 children, or the northern region are the more emitting households. Chancel (2014) studied the generational effect through the impact of date of birth and income on French household CO2 emissions. Comparing emissions in the top and bottom decile households, he found around twice as much emissions in the top decile than in the bottom one.

This article aims at testing the EKC hypothesis for food consumption, which is a major source of emissions, and concern in the climate change perspective. Food is estimated to be responsible for 30% of Greenhouse gas emissions (GHG) in Europe. Improving its sustainability potential is a main issue on the world environmental agenda and changes in diet and in purchase behavior seem to be unavoidable. Therefore, its relation with the level of income is an important issue. Food purchases have been estimated to emit around 1t CO2 eq per year per household (Boeglin et al. (2012)). Income disparities in the food purchase basket have been found among French households (Caillavet et al. 2009).These may lead to differentiated environmental impacts of food according to income, which have not been measured yet. Indeed, for each income class a different price per kg (obtained by dividing expenditure dedicated to purchases by the corresponding quantities) is found at the level of each food group, reflecting different purchase strategies in terms of quality of foods, origin of the products, amount purchased, distribution mode, packaging, … It is well-known that this price increases with income (Caillavet et al. 2009, Beatty 2010), and that income favours a diet of higher nutritional quality (Maillot et al. 2007). However, no specific relationship between income and environmental impact can be expected a priori. Recently, the environmental content of the diet has been studied in the French case by Vieux et al. (2013) and Masset et al. (2014). They show a complex relationship between environment, nutritional characteristics of foods, and the foods composition of the diet. In this framework, the link with income-related patterns of consumption is not clear.

Our paper involves several contributions to the study of the relationship between income and food-related emissions. First, it provides estimations of CO2 impact of food purchases for food-at-home by income levels in France, thus allowing to test the Environmental Kuznets Curve hypothesis for this sector. Second, it highlights a paradox between CO2 emissions and caloric-normalised CO2 emissions when adjusted on income, evidencing contrary slopes. Third, it provides factors of explanation lying in the social patterns and the structure of food-at-home consumption.

This article is organized as follows. Section 2 describes the method and data used. Section 3 presents the results of the environmental emissions. Section 4 discusses the main results. Section 5 concludes.

2- Methods

21- Data

For *food purchases*, we use Kantar Worldpanel data. This survey contains four-week food acquisitions for food-at-home consumption. It delivers quantities and expenditures for a wide range of food products. The households are selected by stratification according to several socioeconomic variables. All participating households register the grocery purchases through the use of bar codes. However, to alleviate its workload, each household is requested to register its purchases for a restricted set of products only. Consequently, the whole purchases for food-at-home are not available for each household.

Due to the structure of the data, we need to aggregate household on representative population groups (Allais et al., 2010) to take into account the whole purchases for food at-home and hence the total CO_2 emissions. In order to capture income effects, life cycle effects, and regional heterogeneity, these population groups are constructed using the following variables:

1. Four income classes, based on family income corrected by consumption units (CU) according to OECD scale. Taking into account the demographic structure of the household, this scale counts 1 for a single adult, 0.7 for a supplementary adult and 0.3 for any member less than 15 years old. On this base, we obtain the following classes, corresponding to quartiles of household income per CU: modest, lower-average, upper-average, well-off households;

2. Four age groups based on the age of the household head: under 30 years old, 31-45, 46-60, over 61;

3. Three regions with significant differences over food purchases: Paris and its suburbs; the North and the East; the South and the West.

Hence we constructed 48 cohorts. For each cohort, purchases are observed for 169 periods of four weeks from 1998 to 2010. This gives 8112 observations representing purchases for 48 population groups.

To compute food purchases emissions, we aggregate food purchases into 21 categories taking into account the range of environmental emissions and the nutritional contents of the products (according to Masset et al. 2014 results). In particular, food groups were differentiated according to their animal or plant-based content.

Environmental data were collected by Greenext, an environment consultancy, to assign the environmental impact of products through Life Cycle Analysis, using the ISO14040-44 standards: “compilation and evaluation of the inputs, outputs and the potential environmental impacts of product system throughout its life-cycle”. The environmental impact indicator estimated therefore includes the impacts associated with each stage of the 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. The Greenext method is presented in more detail on their website (www.greenext.eu). The data set delivers for 311 products the environmental impact of producing these products through different indicators. In particular, they are illustrated by CO2 emissions, which is the main indicator used in the literature. CO_2 relates to the impact on Greenhouse Gas Emissions (expressed in gram of CO_2 equivalent per 100grams). Our analysis will focus on this indicator. It is used to convert quantity of food purchases into quantities of food emissions related to CO2. These values are compared to energy intakes due to food consumption, which requires additional information on nutrient content of food products.

The *energy content of food purchases* comes from the CIQUAL nutritional table and concerns more than 500 food products. The caloric equivalent of food product is measured in food kilocalories. Commonly to nutrition literature, we normalize food purchases to a daily intake of 2000 kilocalories, which enables us to compare different food baskets at a normalized level of energy intakes.

Hence, for each food group, we computed the amount of emissions (resp. energy content) on a daily basis by cohort. Then we aggregated the amount of emissions over the 21 food groups to deliver the total level of emissions (resp. caloric intakes) for each cohort and each time period.

3- Results and Analysis

31- Descriptive statistics

The sociodemographic description of our sample, total and by income class (quartiles of household income per CU), is given in Table 1. We can characterize the modest households (1^{st} quartile) with the usual socioeconomic status characteristics, compared with the well-off class (4^{th} quartile): 80% live with a family income under 1500€/month, their reference person did not achieve in 82% of the cases the baccalaureate level (vs 31%), 36% are inactive or retired (vs 26%), 28% are blue collars (vs 5%). Sociodemographic variables indicate that the majority of modest households include children (68%) and 47% include at least one child under 16 years. Corresponding figures for well-off households are respectively 22% and 12%. Home-owners are less frequent (40% of modest households but 61% of well-off households). An interesting feature is in this context the higher proportion of kitchen gardens in modest households (46% vs 42%). It may in part correspond to the spatial distribution of the population: modest households live more in rural or weakly dense areas (36% vs 24%), and less in urban areas over 200,000 inhabitants (42% vs 55%). The level of home equipment is for some goods inferior compared to other income groups: on average, these households have at home less computers and less dishwashers.

These characteristics induce diet disparities, as shown in table 2 which presents the total energy content of each food group purchases for the whole sample, and per income classes.

The main sources of energy in food-at-home purchases come primarily from plant-based foods high in fats which represent 16.3% of calories for the poorest households and 15.7% for the richest households. Then dairy products, with a higher share of yogurts for the poorest households than for the richest (8.4% vs 7.7%), while we observe the opposite with cheese (7.6% vs 8.9%). Plant-based foods high in sugar contribute slightly more in the richest class (7.5% vs 7.3%), while prepared desserts contribution is slightly lower (7.0% vs 7.3%). Among animal products, animal fats are the main source of calories and bring more to the poorest households (7.2% vs 7.0%). Among drinks, alcohol brings more energy in richest households (6.7% vs 6.4%) while it is the opposite in the case of soft drinks (5.2% vs 5.5%). On the whole, the total contribution of animal-based products to energy purchased does not vary with income: 45.6% for the poorest and 45.5% for the richest. In terms of normalized content, results are only slightly different and the hierarchy of products is not modified. However, note that for some food groups, the gap between lowest and highest income classes is amplified: this occurs for beef, cooked meats, yogurt and prepared desserts.

The corresponding CO2 emissions are presented in table 3, for the whole sample and per income classes. Total CO2 emissions due to food-at-home amount to 1.43 tons CO2 equivalent. Turning our CO2 estimation into daily equivalent, we obtain 3.9kg per household. Adjusted on daily energy of 2000kcal, we find 2.5kg per household.

32- Estimations

We denote here *e* each environmental indicator or nutrient intake, and we estimate the following equation for each *e*:

$$y_{ct}^{e} = \alpha_0 + \alpha_c + \sum_{j=1}^{K} \beta_j \, Z_{jct} + \varepsilon_{ct},$$

where y_{ct}^{e} denotes the log of total level of emission due to food purchases for cohort *c* and time *t;* Z_{jct} is a set of sociodemographic variables, and β_j sociodemographic parameters to be estimated; α_c is a cohort fixed effects which will be detailed in the following paragraphs; and ε_{ct} is the residual. This equation introduces a fixed effect per cohort as well as sociodemographic variables. Estimation results are presented in Table 4.

First, to focus on income disparities, we assume no age effects on emission, i.e. $\alpha_c = \sum_{inc=1}^{4} \alpha_{inc} I_{inc}$, where I_{inc} indicates each dummy variable for WO, UA, LA and MO (respectively Well-Off, Upper-Average, Lower-Average and Modest households). Second, we decompose α_c to measure both income and age disparities with cross interactions such that: $\alpha_c = \sum_{ia=1}^{16} \alpha_{ia} I_{ia}$, where I_{w} indicates income age interaction dummy variables. Third, we assume a potential regional effect by considering $\alpha_{iar} = \sum_{iar=1}^{48} \alpha_{iar} I_{iar}$. Finally, we run the same estimations for the level of CO2 emissions adjusted for energy intake.

33- Results

Income disparities in CO2 emissions

A first glance reveals income disparities in CO2 emissions due to food purchases. Per income class (table 3), we find that the well-off households purchases produce less CO2 emissions (3.4kg) than modest households (3.9kg). (Figure 1 : Adjusted Daily CO2 Emissions per Income Classes). A further regression analysis of CO2 emissions on the level of income per CU is statistically significant ($p<0.001$). Our data show that the level of CO2 emissions is related positively to the 2 lower income groups (modest and lower-average), well-off households being the reference class (table 4, column 1).

Income disparities in CO2 emissions normalized by caloric intake

Regarding the level of emissions normalized by daily 2000kcal, it turns out to be the opposite: well-off households purchases show now a higher emission level of CO2 (2.6kg CO2 equivalent vs 2.5kg for modest households). As observed in graph 2, CO2 emissions appear to increase with household income per CU. We find that income is still significant ($p<0.05$). However, the level of CO2 emissions is now observed to be negatively related to income. The estimated effect shows in this case a low value (table 4, column 2).

Income disparities in emission levels and age

In order to separate the disparities due to differences in the lifecycle position from socioeconomic disparities, we computed the level of energy-related emissions according to income by age of the household head. Table 4, column 3 shows the presence of an age effect which is positively related with level of emissions: compared to the reference group of younger households (head under 30 years), older households, whose head is 45-60 and over 60, are associated with increased levels of emissions ($p<0.001$). Interactions between age and income are also found ($p<0.05$) and show a positive relationship of middle-age households (20-45 and 45-60) in lower-average income class with CO2 emissions. Consequently, even after adjusting on age and age-income interactions, lower income classes are still negatively related to the level of emissions when compared to the richer class (well-off households).

We represent in graph 3 the age-adjusted level of energy-related CO2 emissions by income class. We observe that income disparities exist at the level of each age group, in particular between well-off and modest households. However, in the cases of household heads over 30 years, the existence of significant disparities between the intermediate income classes (lower-average and upper-average households) is not always clear, as shown by overlapping of the confidence intervals.

Emission levels according to the structure of food purchases and income disparities

Table 3 shows the amount of CO_2 emissions according to the structure of purchases disaggregated in 21 food groups.

At the global level as well as normalised by caloric intake, the most impacting food groups are beef (838.41 gCO2eq/100g), alcohol (421.82g), and bottled water (418.55g). Though this hierarchy of impacting food groups remains similar by income class, their contribution to CO_2 emissions may vary.

The contribution of foods with animal content to CO_2 emissions is slightly higher for modest households than for well-off households, at the global level of emissions (51.3 vs 48.6%) as well as in normalized basis (49.3% vs 48.7%). In particular, for modest households purchases compared to well-off, the normalized CO_2 impact is lower for several food groups, in particular: alcohol (11.0 vs 11.2%), fresh fruits and vegetables (2.6 vs 2.8%), plant-based foods high in sugar (2.4 vs 2.8%), fish (2.0 vs 2.2%), prepared dishes (2.0 vs 2.1%), while it is higher for several animal products: beef (21.8 vs 21.6%), cooked meats (4.4 vs 4.3%), animal fats (6.2 vs 5.9%), and also for starchy foods (2.8 vs 2.5%).

4- Discussion

Our estimation of total CO_2 emissions for food at home which amounts to 1.43 tons CO_2 equivalent can be compared to 1.4 tons CO_2 equivalent estimated by Boeglin for the current purchases basket of a French household (not restricted to food). When restricted to food, it would represent roughly 1 ton CO_2-eq. A Swedish estimation finds 1.1 ton CO_2-eq per capita (Wallen et al., 2004), therefore suggesting a higher value per household.

When considering our CO_2 daily equivalent estimation (3.9kg per household), it appears lower than another estimation run on French full-diet data which amounts to 4.1kg per person

(Vieux et al. 2012). However, contrary to our sample, this latter study includes consumption of food away from home. An estimation on UK data still obtains higher values since the average diet embodies 8.8kg CO2 equivalent per person (Hoolohan et al. 2013).

Our results evidence income disparities in the levels of environmental emissions caused by food purchases for food-at-home, which are statistically significant. From this, we draw a decreasing relationship between level of income and environmental footprint caused by food. This is in tune with Boelgin's results based on occupation categories. Lower scale occupations: blue collars (+20%), white-collars, inactive other than retired, and farmers (all around +6%) have emissions above the average. Executives (-16%), intermediate occupations and retired (-5%) are under the average. In the framework of an EKC, it would correspond to the backward slope once the turning point has been overpassed.

However, taking into account the caloric content of food purchases, which allows to normalize consumption with regards to density of the diet, turns out to be crucial since it produces a puzzling paradox: in fact, the decreasing trend with income per CU (as shown in graph 1: well-off households producing less CO2 (3.4kg) than modest households (3.9kg)) turns out to be an increasing trend with income per CU when dealing with adjusted caloric emissions (as shown in graph 2: well-off households purchases show now a higher emission level of CO2 (2.6kg CO2 equivalent vs 2.5kg for modest ones)). In an EKC framework, an increasing slope would correspond to a pattern where consumption is still driven by more polluting goods when income is higher.

How can this paradox be explained ? When it is not normalized by daily energy intake, we find both a higher level of environmental emissions and a higher calories content in modest households purchases than in richer households ones (tables 2 and 3). Indeed, our data show (table 2) that the energy content of purchases for modest households is higher than the well-off ones (3100 kcal vs 2637). A first explanation lies in different food patterns between food-at-home and food-away-from-home between these households. In a previous analysis of French budget data, Caillavet et al. (2009) observed that the budgetary share for food-at-home is higher for lower income households than for higher income groups. Richer households eat more frequently away from home. One second element lies in the food structure of purchases according to income. When we compare the energy content of purchases between modest and well-off households (table 2), we observe for the former more calories coming from soft-drinks, plant-based foods high in fats, starchy food, meats other than beef, cooked meats, animal food high in fats, yogurt, prepared meals and desserts. Most of these food groups bring comparatively lower CO2 emissions than food groups overrepresented in well-off households purchases such as cheese, or fish, fresh fruits and vegetables.

Then, when we compare the levels of emissions associated to food groups according to income class (table 3), we find that higher caloric energy is not necessarily equivalent to higher emissions, since purchases of modest households are more important in terms of energy content on low-producing emissions groups such as soft drinks, yogurts, plant-based foods high in fats. In effect, these latter products are among the lowest values of the scale ranging food groups according to their level of CO2 emissions (see Masset and al. 2014). Just as food groups, which are high producers of CO2 emissions such as cheese or fish, or bring more calories to well-off households and then contribute to more emissions. This complex relationship between density in calories and environmental emissions is an important issue for income disparities.

Finally, the demographic structure of the households may differ among income classes and could explain part of the disparities in the structure of food purchases. This explains why the income effect is reduced when adjusting on age of the household head. This latter variable is a good indicator of the position of the household in the lifecycle and thus acts as a proxy for household composition (number of members, presence of children, working-age adults…).

Our analysis has some policy implications, by pointing out the importance of the unit of measurement of food-related emissions. By taking into account the caloric content of the food-at-home diet, an environmental policy should switch targets: from the apparently most-emitting modest households to the well-off households when emissions potential is adjusted by calories. Therefore information tools or education programs, which are known to be more efficient among highest income groups in the context of nutritional policies (Capacci et al. 2012), could be used to help reduce the environmental impact of food consumption.

5- Conclusions

Total CO2 emissions for food at home amount to 1.43 tons CO2 equivalent. Turning our estimation into daily equivalent, we obtain 3.9kg CO2 equivalent per household. Our estimation is consistent with other evaluations on French data, but remains lower than Swedish or UK evaluations for food consumption.

We test the EKC hypothesis by presenting estimations of CO2 emissions disaggregated by income class. We find that income disparities in CO2 emissions are statistically significant. Income disparities, when adjusted on age, are still significant though modest.

We take into account the compatibility of environmental objectives with health constraints and present estimations of CO2 normalized on caloric intakes. Thus, we find an interesting paradox: lowest income households show the highest level of CO2 emissions at the global level of purchases (+14.7% compared to well-off households), but the lowest level on an normalized 2000 kcal basis (- 9.6%). Consequently the relationship between environmental emissions and income is increasing at the global level, but decreasing when caloric-normalized.

Policy implications could be moderated by data restrictions. Firstly, our estimation is based on purchases and restricts to food-at-home, which underestimates the scope of food consumption and therefore CO2 emissions. This underestimation is not neutral according to income, the richest households consuming a higher share of food-away-from home than poorest ones. Second, due to the structure of Kantar Worldpanel data, we had to build representative population groups to recover the full purchases amount, hence the total calories and total CO2 emissions amounts. In doing so, we had to average several key variables such as age, region, and family structure on 48 population subgroups, which reduces the variability of our sample. But it means that what we could measure is a benchmark estimation and that socioeconomic disparities are wider than what we observed. This strengthens the robustness of our conclusions.

Finally our analysis is based on a single indicator, CO2 emissions, while other parameters (water for example…) could be taken into account to better evaluate the environmental impact of foods. In particular, this could modify the characterization of the highest emitting income class. However Masset et al. (2014) found that air acidification and freshwater eutrophication indicators were strongly correlated with CO2 emissions.

In conclusion, in an EKC framework, the environmental footprint of food purchases would be represented by a decreasing slope with income. However, our analysis shows how the structure of purchases differs between income classes and finds that, once caloric-normalized, this slope has an opposite trend, since richer households' purchases favour higher emitting food groups than lower income households. These results give interesting policy perspectives. They show that richer households should be the first target of diet change since their consumption favours higher CO2 emitting food groups than lower-income households, at caloric level constant. In this perspective, information and education tools seem advisable since they are known to be more efficient on upper income groups.

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Table 1: Descriptive statistics

Variable	Total sample		Well-Off		Upper-Average		Lower-Average		Modest	
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Household income €/month										
[0; 900[	0.09	0.17	0.00	0.00	0.00	0.00	0.05	0.05	0.32	0.20
[900; 1500[	0.21	0.21	0.00	0.00	0.12	0.08	0.25	0.15	0.48	0.14
[1500; 2300[	0.25	0.17	0.18	0.14	0.23	0.11	0.43	0.12	0.18	0.15
[2300; 3000[	0.17	0.15	0.14	0.08	0.33	0.11	0.20	0.13	0.02	0.05
[3000; [	0.27	0.30	0.69	0.13	0.32	0.19	0.06	0.09	0.00	0.00
Education of head of household										
Low degree diploma	0.41	0.17	0.23	0.11	0.42	0.11	0.52	0.11	0.49	0.15
Level of baccalaureate	0.15	0.08	0.19	0.07	0.19	0.07	0.14	0.07	0.09	0.07
Baccalaureate and higher degree	0.24	0.21	0.50	0.16	0.25	0.14	0.11	0.08	0.09	0.11
Socio-professional category of head of household										
Farmer	0.01	0.02	0.00	0.01	0.00	0.01	0.01	0.01	0.03	0.04
Artisan	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.03
Executive	0.12	0.15	0.30	0.18	0.13	0.08	0.05	0.04	0.02	0.03
Intermediary profession	0.19	0.14	0.26	0.16	0.24	0.14	0.17	0.09	0.08	0.06
Employee	0.18	0.12	0.11	0.07	0.19	0.11	0.22	0.12	0.20	0.12
Worker	0.17	0.15	0.05	0.05	0.13	0.08	0.23	0.15	0.28	0.18
Retired	0.26	0.36	0.26	0.36	0.27	0.37	0.26	0.36	0.24	0.36
Without child	0.52	0.33	0.78	0.15	0.59	0.25	0.40	0.34	0.32	0.32
With at least one child (<15)	0.32	0.30	0.12	0.12	0.26	0.23	0.42	0.33	0.47	0.32
Owner	0.52	0.24	0.61	0.24	0.56	0.24	0.50	0.22	0.40	0.23
Individual house	0.54	0.22	0.49	0.21	0.54	0.21	0.57	0.20	0.53	0.24
Kitchen garden	0.47	0.20	0.42	0.19	0.48	0.19	0.50	0.19	0.46	0.21
Household equipment										
Personal computer	0.63	0.28	0.71	0.23	0.66	0.25	0.59	0.28	0.54	0.30
Fryer	0.71	0.13	0.59	0.12	0.70	0.10	0.77	0.09	0.76	0.14
Dish washer	0.52	0.16	0.60	0.17	0.55	0.15	0.51	0.13	0.42	0.15
Freezer	0.48	0.15	0.41	0.15	0.47	0.14	0.53	0.13	0.52	0.16
One car	0.49	0.12	0.50	0.12	0.47	0.12	0.49	0.12	0.52	0.10
Two cars and more	0.40	0.18	0.43	0.17	0.46	0.17	0.41	0.19	0.29	0.16
Type of housing										
Rural area	0.20	0.13	0.16	0.11	0.18	0.11	0.22	0.12	0.25	0.16
Urban area from 2,000 to 10,000 inh.	0.10	0.06	0.08	0.05	0.10	0.05	0.12	0.05	0.11	0.06
Urban area from 10,000 to 50,000 inh.	0.10	0.05	0.10	0.07	0.10	0.04	0.11	0.04	0.10	0.05
Urban area from 50,000 to 200,000 inh.	0.11	0.08	0.11	0.09	0.12	0.08	0.11	0.08	0.11	0.08
Urban area 200,000 inh. and more	0.48	0.28	0.55	0.27	0.50	0.26	0.44	0.27	0.42	0.30
Nobs.	8112		2028		2028		2028		2028	

Table 2: Contribution of food groups to energy by income class

	Total				Well-off				Upper-Average				Lower-Average				Modest			
Food groups	Energy		Eq 2000kcal		Energy		Eq 2000kcal		Energy		Eq 2000kcal		Energy		Eq 2000kcal		Energy		Eq 2000kcal	
	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%
Juices	139.19	4.54%	88.89	4.44%	120.98	4.59%	90.70	4.54%	127.35	4.62%	91.27	4.56%	133.49	4.58%	90.05	4.50%	138.55	4.47%	87.17	4.36%
Alcohol	190.86	6.23%	122.21	6.11%	176.10	6.68%	130.52	6.53%	176.14	6.39%	125.14	6.26%	184.96	6.35%	125.21	6.26%	196.73	6.35%	124.60	6.23%
Soft drinks	163.67	5.34%	104.27	3.40%	137.97	5.23%	103.80	5.19%	142.98	5.19%	103.06	5.15%	151.25	5.19%	102.91	5.15%	171.30	5.53%	106.41	5.32%
Water	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Coffee and tea	11.57	0.38%	7.76	0.25%	11.10	0.42%	8.53	0.43%	11.28	0.41%	8.32	0.42%	11.41	0.39%	8.03	0.40%	11.54	0.37%	7.70	0.39%
Fresh fruits and vegetables	36.12	1.18%	23.23	0.76%	33.35	1.26%	24.59	1.23%	34.40	1.25%	24.33	1.22%	34.91	1.20%	23.50	1.17%	36.29	1.17%	23.21	1.16%
Grains	50.23	1.64%	32.02	1.04%	48.80	1.85%	33.97	1.70%	49.38	1.79%	32.95	1.65%	48.56	1.67%	32.50	1.62%	51.34	1.66%	32.55	1.63%
Plant-based foods high in fats	490.99	16.02%	323.23	10.54%	413.37	15.67%	315.26	15.76%	431.24	15.65%	316.04	15.80%	459.24	15.76%	318.04	15.90%	504.88	16.28%	327.65	16.38%
Plant-based dishes	120.17	3.92%	78.98	2.58%	106.03	4.02%	81.24	4.06%	110.14	4.00%	80.46	4.02%	115.33	3.96%	79.94	4.00%	121.07	3.91%	78.80	3.94%
Plant-based foods high in sugar	224.25	7.31%	147.61	4.81%	197.36	7.48%	150.49	7.52%	204.62	7.43%	149.36	7.47%	213.64	7.33%	147.65	7.38%	227.60	7.34%	148.69	7.43%
Starchy foods	182.52	5.95%	119.41	3.89%	151.85	5.76%	116.24	5.81%	160.92	5.84%	117.53	5.88%	172.65	5.93%	118.84	5.94%	183.31	5.91%	118.70	5.93%
Processed fruits and vegetables	44.86	1.46%	29.69	0.97%	40.30	1.53%	30.94	1.55%	41.42	1.50%	30.48	1.52%	43.34	1.49%	30.11	1.51%	45.26	1.46%	29.74	1.49%
Beef	101.34	3.31%	66.04	2.15%	88.00	3.34%	67.01	3.35%	90.59	3.29%	66.01	3.30%	96.68	3.32%	66.50	3.33%	103.43	3.34%	66.57	3.33%
Other meats	109.63	3.58%	71.37	2.33%	91.32	3.46%	69.27	3.46%	95.12	3.45%	69.16	3.46%	103.52	3.55%	70.87	3.54%	111.95	3.61%	71.98	3.60%
Cooked meats	76.22	2.49%	49.70	1.62%	62.95	2.39%	47.99	2.40%	66.48	2.41%	48.40	2.42%	71.90	2.47%	49.29	2.46%	77.02	2.48%	49.69	2.48%
Animal-based foods high in fats	222.21	7.25%	142.67	4.65%	183.19	6.95%	137.26	6.86%	194.55	7.06%	139.23	6.96%	211.24	7.25%	142.50	7.12%	221.82	7.15%	140.88	7.04%
Cheese	236.53	7.72%	157.71	5.14%	235.89	8.94%	181.05	9.05%	237.62	8.63%	174.18	8.71%	236.89	8.13%	165.38	8.27%	234.43	7.56%	156.92	7.85%
Fish and seafoods	36.25	1.18%	24.22	0.79%	33.90	1.29%	26.04	1.30%	34.22	1.24%	25.21	1.26%	35.28	1.21%	24.67	1.23%	36.90	1.19%	24.59	1.23%
Yogurts	262.20	8.55%	170.68	5.57%	201.68	7.65%	153.17	7.66%	223.25	8.10%	162.62	8.13%	243.83	8.37%	166.55	8.33%	259.00	8.35%	165.36	8.27%
Prepared mixed meals	140.70	4.59%	93.45	3.05%	118.34	4.49%	91.75	4.59%	124.51	4.52%	92.08	4.60%	132.06	4.53%	92.13	4.61%	143.16	4.62%	94.45	4.72%
Prepared desserts	227.01	7.40%	147.35	4.81%	185.31	7.03%	140.54	7.03%	199.02	7.22%	144.34	7.22%	213.58	7.33%	145.53	7.28%	226.72	7.31%	145.36	7.27%

Energy content (kcal/day)	**3065.77**	**100%**	**2000.00**	**100%**	**2637.31**	**100%**	**2000.00**	**100%**	**2754.98**	**100%**	**2000.00**	**100%**	**2913.50**	**100%**	**2000.00**	**100%**	**3100.36**	**100%**	**2000.00**	**100%**

Table 3: Contribution of food groups to CO2 Emissions by income class

	Total				**Well-off**				**Upper-Average**				**Lower-Average**				**Modest**			
Food groups	Emissions		Eq 2000kcal		Emissions		Eq 2000kcal		Emissions		Eq 2000kcal		Emissions		Eq 2000kcal		Emissions		Eq 2000kcal	
	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%	mean	%
Juices	319.98	8.21%	204.34	8.08%	278.17	8.05%	208.55	8.01%	292.78	8.21%	209.84	8.16%	306.87	8.19%	206.99	8.09%	318.51	8.09%	200.38	7.93%
Alcohol	421.82	10.82%	270.63	10.71%	393.45	11.39%	291.69	11.20%	390.04	10.94%	277.18	10.78%	411.31	10.98%	278.83	10.90%	435.76	11.06%	276.93	10.95%
Soft drinks	176.21	4.52%	111.94	4.43%	151.58	4.39%	113.51	4.36%	156.36	4.38%	112.28	4.37%	164.03	4.38%	111.33	4.35%	183.90	4.67%	113.88	4.50%
Water	418.55	10.73%	270.85	10.72%	358.09	10.37%	272.55	10.47%	380.30	10.66%	275.99	10.73%	397.02	10.60%	271.78	10.62%	417.87	10.61%	266.49	10.54%
Coffee and tea	14.13	0.36%	9.44	0.37%	11.92	0.34%	9.22	0.35%	12.39	0.35%	9.24	0.36%	13.23	0.35%	9.28	0.36%	14.56	0.37%	9.59	0.38%
Fresh fruits and vegetables	103.92	2.67%	66.92	2.65%	99.73	2.89%	73.39	2.82%	101.70	2.85%	71.89	2.79%	102.00	2.72%	68.63	2.68%	103.86	2.64%	66.71	2.64%
Grains	101.04	2.59%	65.74	2.60%	95.83	2.77%	70.02	2.69%	98.29	2.76%	68.69	2.67%	98.10	2.62%	66.97	2.62%	101.55	2.58%	65.84	2.60%
Plant-based foods high in fats	95.17	2.44%	62.71	2.48%	81.10	2.35%	61.89	2.38%	84.42	2.37%	61.89	2.41%	89.62	2.39%	62.06	2.43%	97.41	2.47%	63.35	2.51%
Plant-based dishes	65.05	1.67%	42.91	1.70%	65.09	1.88%	49.02	1.88%	65.01	1.82%	47.12	1.83%	64.78	1.73%	44.66	1.75%	65.48	1.66%	43.05	1.70%
Plant-based foods high in sugar	89.83	2.30%	59.30	2.35%	94.72	2.74%	71.79	2.76%	92.56	2.60%	67.17	2.61%	91.20	2.43%	63.13	2.47%	90.62	2.30%	60.09	2.38%
Starchy foods	107.69	2.76%	70.96	2.81%	83.21	2.41%	64.63	2.48%	91.09	2.55%	67.18	2.61%	99.19	2.65%	68.87	2.69%	108.31	2.75%	70.49	2.79%
Processed fruits and vegetables	70.40	1.81%	46.86	1.85%	63.28	1.83%	48.77	1.87%	65.54	1.84%	48.32	1.88%	68.41	1.83%	47.70	1.86%	70.13	1.78%	46.46	1.84%
Beef	838.41	21.50%	548.08	21.68%	738.58	21.38%	562.35	21.60%	756.95	21.23%	551.79	21.45%	806.04	21.51%	555.00	21.69%	852.46	21.64%	551.69	21.82%
Other meats	200.76	5.15%	130.45	5.16%	177.58	5.14%	133.84	5.14%	182.78	5.13%	131.90	5.13%	193.13	5.15%	131.86	5.15%	203.18	5.16%	130.98	5.18%
Cooked meats	172.57	4.43%	112.25	4.44%	145.98	4.23%	110.81	4.26%	153.03	4.29%	110.93	4.31%	164.88	4.40%	112.76	4.41%	173.22	4.40%	111.63	4.42%
Animal-based foods high in fats	248.81	6.38%	159.68	6.32%	205.76	5.96%	154.00	5.91%	218.38	6.12%	156.17	6.07%	236.81	6.32%	159.64	6.24%	248.18	6.30%	157.55	6.23%
Cheese	35.10	0.90%	21.29	0.84%	28.77	0.83%	20.39	0.78%	30.99	0.87%	21.13	0.82%	33.39	0.89%	21.27	0.83%	34.57	0.88%	20.57	0.81%
Fish and seafoods	74.32	1.91%	49.53	1.96%	73.29	2.12%	56.06	2.15%	72.62	2.04%	53.01	2.06%	73.81	1.97%	51.42	2.01%	75.51	1.92%	50.70	2.01%
Yogurts	11.01	0.28%	5.38	0.21%	11.49	0.33%	6.46	0.25%	11.54	0.32%	6.23	0.24%	11.35	0.30%	5.82	0.23%	10.62	0.27%	5.16	0.20%
Prepared mixed meals	74.51	1.91%	48.93	1.94%	71.39	2.07%	53.71	2.06%	71.96	2.02%	52.13	2.03%	73.15	1.95%	50.22	1.96%	75.30	1.91%	49.22	1.95%
Prepared desserts	260.66	6.69%	169.85	6.72%	225.58	6.53%	171.30	6.58%	237.54	6.66%	172.31	6.70%	248.93	6.64%	170.30	6.66%	260.43	6.61%	168.40	6.66%
CO2 Emissions (g eq. CO2/day)	**3899.14**	**100%**	**2527.52**	**100%**	**3454.30**	**100%**	**2603.76**	**100%**	**3566.14**	**100%**	**2572.30**	**100%**	**3747.10**	**100%**	**2558.40**	**100%**	**3939.34**	**100%**	**2528.09**	**100%**

Table 4: Estimation results

Variables	Log(CO_2 emissions)		Log(CO2 emissions eq. 2000 kcal)		Log(CO2 emissions eq. 2000 kcal)	
Well-Off	Ref.		Ref.		Ref.	
Upper-Average	0.067		-0.023		-0.036	***
Lower-Average	0.161	***	-0.034	*	-0.060	***
Modest	0.231	***	-0.062	***	-0.079	***
Age -;30]					Ref.	
Age]30;45]					0.014	
Age]45;60]					0.059	***
Age]60;+					0.067	***
Well-Off * Age -;30]					Ref.	
Well-Off * Age]30;45]					Ref.	
Well-Off * Age]45;60]					Ref.	
Well-Off * Age]60;+					Ref.	
Upper-Average * Age -;30]					Ref.	
Upper-Average * Age]30;45]					0.014	
Upper-Average * Age]45;60]					0.021	
Upper-Average * Age]60;+					0.016	
Lower-Average * Age -;30]					Ref.	
Lower-Average * Age]30;45]					0.032	*
Lower-Average * Age]45;60]					0.034	*
Lower-Average * Age]60;+					0.038	
Modest * Age -;30]					Ref.	
Modest * Age]30;45]					0.044	*
Modest* Age]45;60]					0.027	
Modest * Age]60;+					-0.004	
Intercept	8.112	***	7.859	***	7.824	***
Nobs	8112		8112		8112	

Note: * p<0.05, ** p<0.01, ***p<0.001

Figure 1 : Adjusted Daily CO2 Emissions per Income Classes

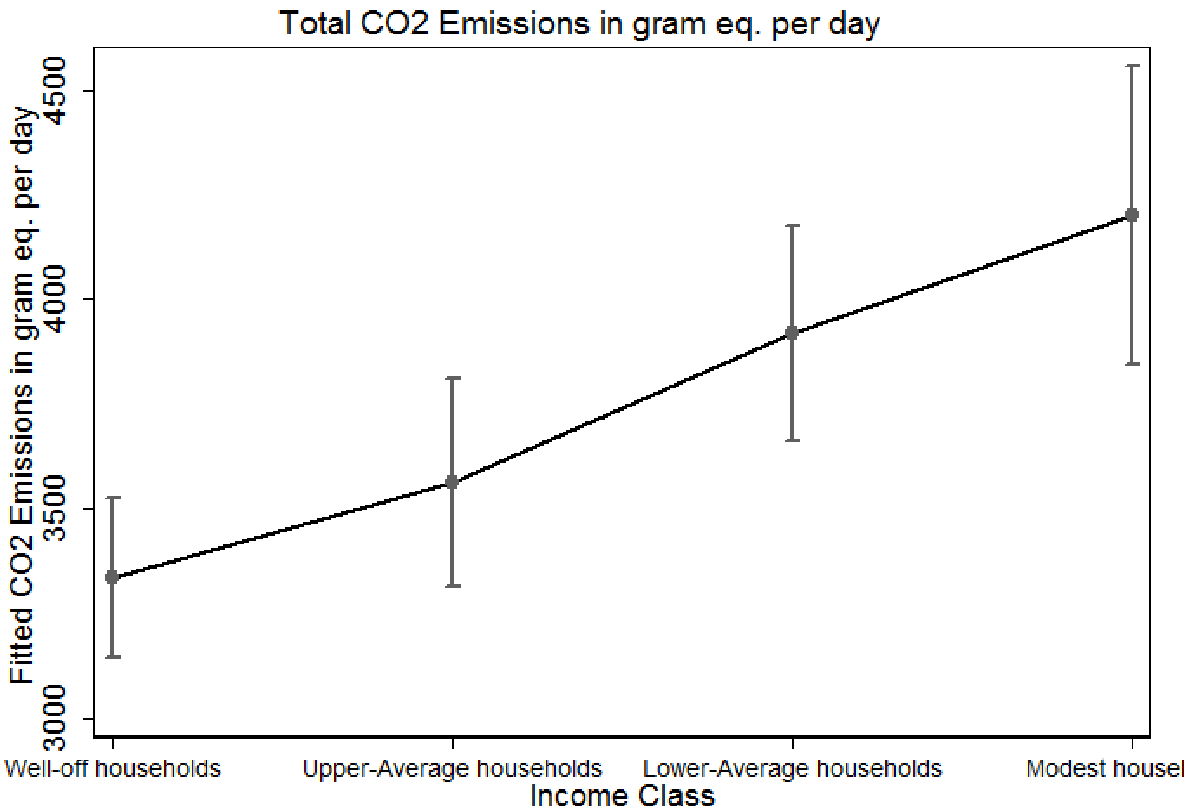

Figure 2 : Adjusted Daily CO2eq/2000kcal Emissions per Income Classes

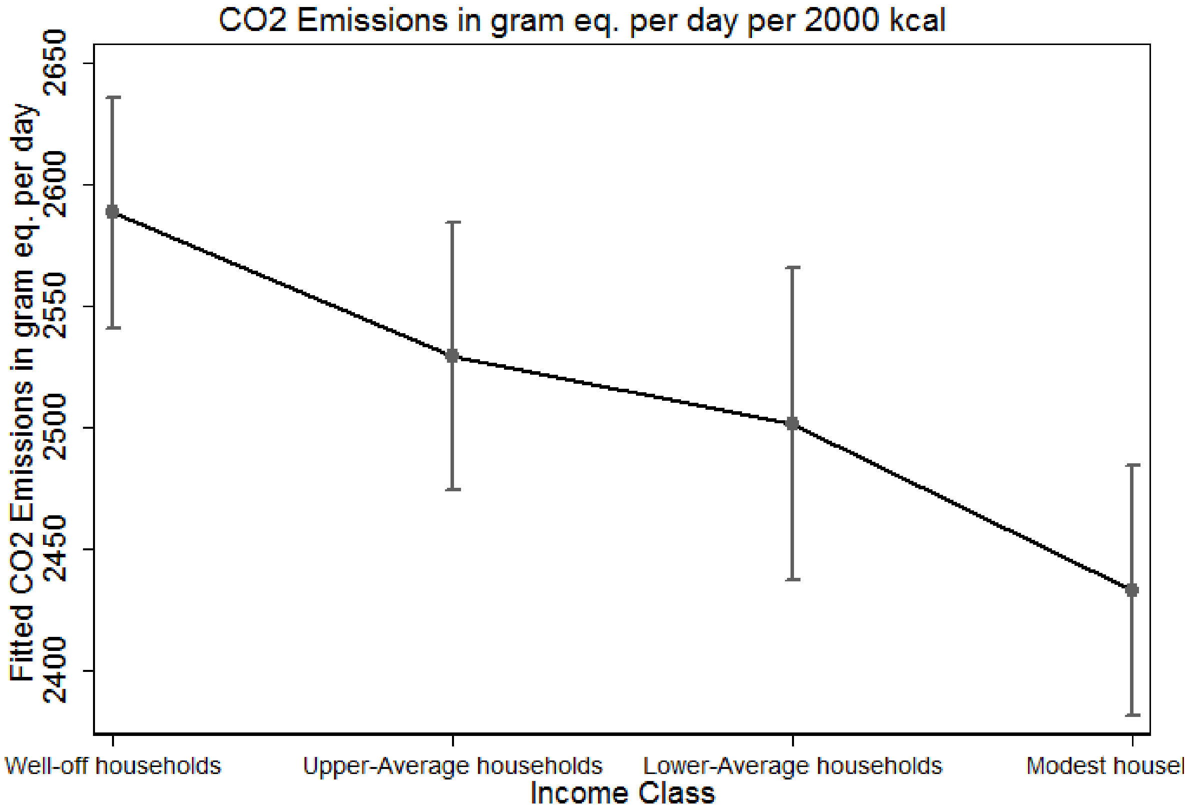

Figure 3: Adjusted Daily CO2eq/2000kcal Emissions per Income and Age Classes