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Testing for the Best Instrument to Generate Sustainable Food Consumption

Luca Panzone[1], Grischa Perino[2], Timothy Swanson[3], and Denise Leung[4]

[1] University of Manchester , United Kingdom ;[2] University of East Anglia, United Kingdom ;[3]Graduate Institute of International and Development Studies, Geneva, Switzerland ;[4] University College London, United Kingdom
luca.panzone@manchester.ac.uk, G.Perino@uea.ac.uk, tim.swanson@graduateinstitute.ch, denise.w.leung@gmail.com.

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ABSTRACT

The increase in the level of greenhouse gas (GHG) emissions in the atmosphere in the last centuries, and the subsequent increase in temperature, has been a widely studied area in the last few decades. Climate change has become a key item on the political agenda due to concerns regarding the sustainability of current human consumption for future generations. Consumption of food and agricultural goods constitutes an important part of household based GHG emissions, and the relatively low costs associated with environmental improvements make it an interesting area of study to understand behavioural changes.

Despite general agreement on the need to curb the amount of GHG emissions worldwide, little evidence exists regarding the best instruments policymakers can employ to stimulate changes toward more sustainable consumption. The present work explores which instruments are most effective in fostering change to more environmentally friendly food consumption. The instruments tested are CO_2 labelling, GHG abatement subsidy and product-specific bans. We used a simulated online shopping trip in supermarkets in the Greater London area in the United Kingdom, where respondents shopped in four product categories: cola, milk, meat (chicken and beef), and butter/margarine. Consumer preferences reveal that, in the presence of these instruments, quantity instruments performed better than price incentives and labelling.

Keywords: Sustainable consumption, Food shopping, Dietary Change, Policy instrument

1 Introduction

Over the last few centuries, the industrialisation that has characterised the Western world has also led to an increase in the level of anthropogenic pollution. In particular, the fast increase in world population has stimulated the development of industrial activities, which was necessary to sustain a rising demand for food and employment. This has caused an increase in the amount of Greenhouse Gases (GHG) produced by human activity, a by-product of industrialisation (Goodland and Anhang, 2009; Metcalf and Weisbach, 2009). Given the importance of environmental protection in current international policy agendas, there is growing consensus of the need to structure and develop more rational "Carbon policies". This term refers to policies that address the environmental problem, regulate the steps needed to reduce externalities, and stimulate sustainable consumption. The design of an effective carbon policy requires a proper understanding of all the actors involved in the production of GHG, and their reaction when different instruments are in place (see e.g. Metcalf and Weisbach, 2009; Weisbach, 2009).

Among the different human activities that contribute to the production of GHG, food consumption plays an important part[*]. The demand for food products is an important determinant in a household's carbon footprint due to the requirement of energy and other inputs for food production and delivery, and the waste generated at every step of the food chain (Carlsson-Kanyama and Gonzales, 2009; Eshel and Martin, 2006). This is especially important, considering that food is an important and essential part of a household's expenditures. However, improvements in a household's carbon footprint from food consumption is a relatively inexpensive process (at least in the short run), as it does not require investments in new technologies, but instead hinges on consumers' choices of food.

The aim of this work is to advise the design of a carbon policy targeting households' food consumption, a consistent part of household expenditures that accounts for a large part of a household's production of GHG. In particular, the objective is to test consumer behaviour in the choice of food when different policy instruments are in place. Surprisingly, this is an area of study where little research has been done. In fact, while there is increasing evidence that diet has a much stronger impact on GHG emissions than it is commonly thought (Carlsson-Kanyama and Gonzales, 2009; Eshel and Martin, 2006), little empirical work has analysed this aspect.

In this paper, consumers are given one of five different policy instruments aimed at improving their carbon footprint. It is supposed to "nudge" them toward the more environmentally friendly food alternative in the particular food category in which they were shopping. These instruments can be grouped into three categories:

a. A price instrument: a subsidy or an exogenous price change that favours the least polluting alternative;

b. A quantity instrument: a ban or an exogenous removal of the most polluting alternative;

c. An information instrument: a label informing consumers about the carbon footprint of their alternatives.

The inclusion of exogenous changes in price and availability allows for the comparison of a treatment where sustainable nudges are caused by structural changes in the economy, and not by policy-makers. This would allow a direct comparison between the effects of a "natural" change, where no intervention is in place, and a policy-induced change for both the price and quantity treatments. To analyse consumers' response to these different instruments, revealed preference data were collected via an online experiment taken in seven supermarkets in the London (UK).

The paper is structured as follows: the next section reviews the existing literature on environmental policy-making, focusing on how policy can stimulate sustainable consumption of market goods. This will be followed by a presentation of the econometric model used in the analysis to estimate the effects of each instrument. Section 4 will report the data collection process, and the data used in the final analysis. Finally, section 5 will present and discuss the results of the experiment, and section 6 concludes the paper.

2 Background

The general objective of environmental policy is to remove all environmental externalities. This can be achieved by either removing the cause of the externality or incorporating the external costs in the final price of the good produced (Cooter, 1984; 2006). This section presents all the instruments used in the experimental part of this project, revising their theoretical implications from an economic standpoint.

The first approach in tackling an externality is to identify and forbid those behaviours that generate it. This policy corresponds to a ban of one or more stages of the production process, hence forbidding the supply of the product. The main alternative regulatory approach is the quantification of the damage. In economic terms, the price of an illegal activity is the external marginal cost (per unit of product) it causes. Consequently, individuals are allowed to generate externalities, provided they pay for the external costs this entails. These external costs are charged to producers, usually through taxation of the polluting activity (Metcalf and Weisbach, 2009). Price-based interventions aim to internalise market externalities, i.e. to incorporate in the full price of a good all those costs not directly paid by the producer. A subsidy will then increase the external marginal costs of supply of the good, and its higher market price will endogenously determine a lower quantity demanded. This will not eliminate pollution, but will induce an

[*] Goodland and Anhang (2009) indicate that agriculture may be responsible alone for more than 50% of the World GHG emissions. The Eurostat database refers that in 2008 in the UK agricultural production only accounts for around 6.9% of total GHG emissions. These values do not account for food processing and food waste.

optimal level of pollution.

Despite their different perspectives, these two approaches converge to a single economic or regulatory approach (Cooter, 1984; Weitzman, 1974). In fact, a prohibition corresponds to an externality charging an infinite cost to the society, and the internalisation would raise prices to infinite, resulting in the prohibition of such activity. Similarly, different crimes receive different punishments, implicitly suggesting different social costs of the externalities they cause.

A last approach to reduce the impact of GHG emissions would be the use of environmental labelling (O'Neill, 2009), i.e. reporting the carbon footprint information of each good in the market. Once the information is provided, consumers have the responsibility to drive change, favouring those products with lower carbon footprint, subject to their budget constraint. The resulting effect not only provides consumers with information, but also acts as a quality signal, as firms may demonstrate their environmental responsibility and their better performance. If the environmental information is then made compulsory through legislation, producers will compete with the aim to reduce their environmental impact in order to attract environmentally conscious consumers.

Improvements in the presence of a carbon label will only occur if consumers value the information. The existence of a price premium for lower carbon footprint and a comparative advantage of environmentally friendly products will act as an incentive for producers to reduce their GHG emissions. The resulting effect is that the externality is reduced using private funds (expenses in labelling and LCA), and the externality can be removed with limited public intervention.

Despite being an obvious strategy for producers to foster sustainable change, CO_2 labelling requires a good level of knowledge to be clearly understood (Boardman, 2008). This tool seems to be effective in stimulating change in grocery shopping, with a more dramatic result when the cleaner product is also cheaper (Vanclay et al., 2010). Marketers explain the phenomenon as a consequence of both demand and supply needs, where consumers demand information that producers are willing to convey (Charles, 2010). Consequently, despite the limited evidence on consumer behaviour and environmental labelling, many retailers have chosen to voluntarily label their own-branded products, and supply a variety of privately labelled alternatives (Billon, 2009; Wyers, 2009).

Implicitly, economists seem to accept the idea of independence between outcomes and the type of policy in use (as in Cooter, 1984). In essence, the final choice of instruments depends on a cost-benefit analysis, where prices are used only if the government can assign a value to an externality (Cooter, 1984). Equality of the response to a policy instrument might not hold perfectly, since people might disagree with direct governmental intervention and leave the marketplace in protest (Eckel et al., 2005). Similarly, additional information on the label may prove ineffective because of the bounded rationality affecting consumer ability to process information (Gigerenzer and Goldstein, 1996). In the present work, this point is tested formally using a consumer experiment to observe the response to three different policy instruments.

3 Econometric model

We model the effectiveness of a policy instrument targeting consumer *j*'s choice of product *i* as a latent construct identified by a variable E. This equals 1 whenever the initial polluter purchases a cleaner alternative, and 0 otherwise. This can be written as

$$\begin{aligned} E_{ij} &= 1 \quad if \quad E_{ij}^{*} > 0 \\ &\quad or \\ E_{ij} &= 0 \quad if \quad E_{ij}^{*} \le 0 \end{aligned} \qquad \text{Equation 1}$$

The effectiveness of a policy can then be modelled as

$$E_{ij} = \alpha_0 + \alpha_1 \cdot D_j + \alpha_2 \cdot T_j \qquad \text{Equation 2}$$

which is the estimated equation, where D_j are household-specific shifters, and T_j is a policy instrument proposed to consumer *j*.

4 Experiment and Data

Data on consumer choice were collected in February and March 2010 in Sainsbury's supermarkets in the Greater London area. Specifically, the experiment covered the areas of Walthamstow, New Barnet, Edgware, Chiswick, Merton, and Lewisham[†]. This retailer accounts for around 27% of the total market share in the study area (16% in all the UK)[‡]. Sainsbury's also has a well developed internet shopping facility that reaches 88% of the total UK population, with over £500 Millions worth of sales in 2009[§].

The experiment was completed entirely at a computer, simulating an online shopping experience. A response station composed of four laptops was set up in the proximity of the entrance to each supermarket. Respondents had to complete the task independently, without the help of the experimenter, whose presence was only logistic.

The experiment collected information on the purchase of four food categories: cola drinks, milk, meat (chicken and beef), and butter or margarine. More specifically, each virtual shopping aisle contained both relatively friendly and relatively unfriendly products (the same number of alternatives for each group). Products included in the experiment are reported in table 1. Respondents were enrolled only if they were about to purchase at least a polluting item (cola in cans, butter, beef, or skimmed milk). In exchange for their time, they received a £5 Sainsbury's voucher, which was given at the end of their shopping trip if and only if they bought the product varieties chosen in the experiment. Milk and butter were chosen for the importance they play in the UK food culture; cola drinks were included to observe the impact of change on packaging; and meat was added due to the importance of this food category in the current debates on sustainability (FAO, 2006; Goodland and Anhang, 2009).

Table 1.
Products included in the experiment

Product category	*Environmentally-friendly options*	*Environmentally-unfriendly options*
Cola (2-liters)	Plastic bottle of: Coca Cola, Diet Coke, Coke Zero, Pepsi Cola, Diet Pepsi, and Pepsi Max	6-cans of: Coca Cola, Diet Coke, Coke Zero, Pepsi Cola, Diet Pepsi, and Pepsi Max
Fresh milk (2-pint)	Skimmed milk	Whole milk, Semi-skimmed milk (1.7% fat)
Meat (various weight)	***Chicken***: chicken breast, mini chicken fillet, drumsticks.	***Beef***: minced meat, casserole steak, braising steak.
Butter/margarine (0.5 kilos)	***Margarine*** (0.5 kilos): Lurpak, Anchor, Flora, Clover, and Sainsbury's own brand.	***Butter*** (0.5 kilos): Lurpak, Anchor, Countrylife, Kerrygold, Sainsbury's own brand

The experiment consisted of three consecutive steps. In the first step, respondents had to select the grocery products they intended to purchase on their shopping trip on the day of the experiment. Respondents could shop in as many of the four categories available as they wanted, and had to indicate which specific products they planned to purchase within each category.

In step 2, information on environmental and nutritional matters associated with food markets were made available to consumers who were interested in accessing it. This information provided a description of the environmental and nutritional problems existing presently in the UK society, why they were relevant in their food shopping, and how to interpret claims on labels. Respondents with no interest in any of these

[†] Each store was surveyed for 16 hours, with the exception of Edgware, which lasted 32 hours.
[‡] Information available on http://www.j-sainsbury.co.uk/index.asp?pageid=451
[§] Information available on http://www.j-sainsbury.co.uk/files/reports/ar2009_report.pdf, page 5. This value only includes food and grocery products, as the non-food area has been launched in 2010

two options could opt out and go directly to the final step of the experiment.

Finally, in the third step participants were randomly allocated to one of five different treatments representing the three different instruments introduced earlier, and given the chance to either confirm or disconfirm their initial choice. At this stage, respondents were reminded that their choice would be binding: they would need to purchase the item chosen at this stage in order to receive the incentive offered. This is a key condition of the experiment: data collected represent revealed consumer preferences for sustainable food consumption, and indicate real market behaviour. The treatments were designed as described in the following subsections.

4.1 Labelling

In this treatment, respondents were shown both nutritional and environmental information referred to each product. While the nutritional information was directly taken from the real label of the product in the list, the carbon information originated from different sources:

- Cola: values for colas were obtained from a report from Coca Cola (Coca Cola, 2009).
- Milk: values for milk were obtained from Tesco[**].
- Meat: values for beef and chicken were found in Williams et al. (2006),
- Butter and margarine: values were obtained from the online website "Time for change" (http://timeforchange.org/eat-less-meat-co2-emissionof-food) that cited the German publication Pendos CO2-Zähler.

The values of the carbon footprint used are reported in table 2.

4.2 Subsidy

In this treatment, respondents were offered the same alternatives as in the labelling treatment, but "cleaner" alternatives were available for purchase at a lower price. Respondents were then told that (in the case of cola) "There has been a price change. Products in plastic bottles have a (value) p discount due to a GOVERNMENT SUBSIDY received on account of its low carbon footprint". Respondents were reimbursed the price difference upon collection of the voucher. The value of the tax was calculated starting from the estimated social cost of carbon, which is £70/tonne carbon[††] as reported in DEFRA (2002, page 41) and commented in Pearce (2003). This was then converted into £/kg of product using the following conversion equation

$$70\frac{£}{tC}\times\frac{12}{44}\frac{tC}{tCO_2}\times 10^6\,\frac{gCO_2}{tCO_2}\times\Delta CF\,\frac{gCO_2}{kg}$$

where CF indicates the carbon footprint. In the case of milk and cola, the resulting value was below 0.5 pennies, and was then multiplied by 10 (for cola) and by 9 (milk) to allow consumers to perceive the price change[‡‡]. The final values of the subsidies are reported in table 2.

[**] Data are available on http://www.carbon-label.com/news/17.08.2009%20-%20Tesco%20Milk%20Press%20Release.pdf

[††] A referee correctly highlighted that this value is not updated, see e.g. Anthoff et al. (2009). However, the value used in the survey can be defended on the grounds that this is the value currently used in governmental institutions in the UK, and therefore consistent with the context in analysis.

[‡‡] As observed by a referee, this would correspond to over-subsidising cola and milk over other products. Albeit this point is correct and acknowledged, it would have been impossible to give consumers any subsidy below 0.05 pennies since there is no coin of this magnitude. This would have made it impossible for the experiment to have any price change scenario for milk and cola.

Table 2.
Carbon footprint and subsidies used for each product category

Product category	*Carbon footprint*[§§]	*Subsidy*
Cola (2-liters)	Plastic bottle: 500 gCO_2[***] Cans: 1,020 gCO_2	£ 0.05 for cola in plastic bottle
Fresh milk (2-pint)	Whole milk: 1,800 gCO_2 Semi-skimmed milk: 1,600 gCO_2 Skimmed milk: 1,400 gCO_2	£ 0.03 for semi-skimmed milk, £ 0.06 for skimmed milk;
Meat (various weight)	Chicken: 5,000 g CO_2 per kilo of meat. Beef: 16,000 g CO_2 per kilo of meat.	£ 0.21 per kilo of chicken meat.
Butter/margarine (0.5 kilos)	Butter: 11,900 g CO_2 Margarine: 675 g CO_2	£ 0.43 for margarine.

4.3 Exogenous price change

This treatment was identical to the subsidy scenario. However, the description justifying the price change reported the following statement (in the case of cola): "There has been a price change. Products in plastic bottles have a (value) p discount because of a change in the price of materials". This sentence conveyed the idea that the price change was not a temporary, but a permanent (i.e. long-term) condition.

4.4 Ban

In this treatment all polluting alternatives were removed from the virtual aisle, leaving respondents to choose only among the clean items. This change was explained using the following wording (in the case of cola): "There has been a change in product availability. Products in can are not available because they have been BANNED by GOVERNMENT ORDER on account of their high carbon footprint". Respondents unwilling to purchase the remaining products could opt out, choosing the "None of the above" option, and recorded as not changing (E_{ij}=0).

4.5 Exogenous price removal

This treatment was identical to the ban treatment. In this case, the absence of some of the products was justified with the following statement (in the case of cola): "There has been a change in product availability. Products are not supplied in cans on account of the lack of availability of the necessary materials".

At the end of the experiment, a positive change was recorded for those individuals who switched from a "dirty" option to a "clean" one (for instance, switched from beef to chicken). After the choice experiment, respondents reported their demographic details. Finally, participants rated the stated importance of a series of labelling signals and their opinions on climate change-related matters and beliefs using 5-point Likert scales, which are reported in table 3. The complete set of signals and statements can be found in table 3 and 4.

In addition to the primary data collected in the experiment survey, a set of secondary data were included in the analysis to complete the dataset. Firstly, the individual level of human development of every respondent was derived from the information on the country of origin using the Human Development Index (HDI) of the United Nations (UNDP, 2009). The importance of this variable arises because developed countries may perceive climate change differently from developing countries, and this variable would capture the information[†††]. Finally, information regarding the occupation of the respondent was used to identify the social class of the respondent. This data was coded in accordance with the information delivered by the UK Office for national Statistics (Office for National Statistics, 2005).

[§§] The rationale within which these values have been calculated is not available. Unfortunately, companies tend to find this information sensitive, and do not inform on how the value is calculated. This was confirmed to us by the Carbon Trust.

[***] Precisely, data on carbon footprint are reported in CO_2 equivalents (CO_2e). This unit is preferred because production processes usually produce different GHG, and their final impact is estimated converting the impact of other gases in the same effect if the gas was CO2. However, in this work we will use CO_2 instead of CO_2e for ease of reporting.

[†††] The data used here can be found at http://hdr.undp.org/en/statistics/data.

5 Results

5.1 Change patterns

Change patterns are presented in tables 3 and 4. In general, change toward a sustainable food alternative is simpler for cola drinks compared to all other products in the dataset. The reason for the high rate of change in this category is due to the fact that the exact same product is sold in two different packages, and the resistance to change depends essentially on the practical aspects of packaging, i.e. possibility to carry heavier weights which are easier to portion.

On the other extreme, milk is the product that shows the highest resistance to sustainable change. In this particular category, respondents seem to find it difficult to choose between the need for a lower carbon footprint and caloric intake (skimmed milk) and the need for what is perceived as a tastier and more nutritious product (whole milk)[‡‡‡] (see also Bus and Worsley, 2003). However, from an economic perspective all types of milk are priced equally, making calories cheaper for whole milk (see e.g Drewnowksi and Specter, 2004, for a discussion on the price of calories). It remains to be said that change in the milk category is somehow underestimated, since we did not consider people switching from whole to semi-skimmed milk.

In terms of instruments, from the analysis of tables 4, it appears that ban and removal are the most effective instruments in achieving dietary change, driving over 60% of changes in all products (the only exception would be the removal treatment in milk). On the other hand, the subsidy treatment seems to be the least successful in driving change. This is surprising because this treatment consisted of a benefit to the respondent that, in fact, decreased the relative price of the cleaner alternative.

Table 3.
Change patterns by food category

	Cola	*Milk*	*Meat*	*Butter*	**Total**
Total purchases	346	825	322	431	1,924
Dirty purchases	208	725	250	194	1,377
Changes	114	182	93	79	468
% change	54.81%	25.10%	37.20%	40.72%	33.99%

Note: changes are calculated with respect to the total number of "dirty" changes.

[‡‡‡] This appeared evident after analysing the answers to the open-ended question asking the motivation of their choice.

Table 4.
Change patterns by instrument

		Info	*Tax*	*Price*	*Ban*	*Removal*	**Total**
Total	Total purchases	380	369	408	372	395	1,924
	Dirty purchases	269	266	307	259	276	1,377
	Changes	46	30	55	172	165	468
	% change	17.10%	11.28%	17.91%	66.41%	59.78%	33.99%
Cola	Total purchases	69	65	68	68	76	346
	Dirty purchases	39	44	46	38	41	208
	Changes	13	12	27	31	31	114
	% change	33.33%	27.27%	58.70%	81.58%	75.61%	54.81%
Milk	Total purchases	165	153	175	157	175	825
	Dirty purchases	140	141	157	136	151	725
	Changes	12	7	10	82	71	182
	% change	8.57%	4.96%	6.37%	60.29%	47.02%	25.10%
Meat	Total purchases	58	67	73	68	56	322
	Dirty purchases	49	50	54	55	42	250
	Changes	11	6	8	38	30	93
	% change	22.45%	12.00%	14.81%	69.09%	71.43%	37.20%
Butter	Total purchases	88	84	92	79	88	431
	Dirty purchases	41	31	50	30	42	194
	Changes	10	5	10	21	33	79
	% change	24.39%	16.13%	20.00%	70.00%	78.57%	40.72%

Note: changes are calculated with respect to the total number of "dirty" changes.

5.2 Factor analysis

Respondents were asked to rate the level of importance they attached to 18 signals on a 5-points likert scale, and these were reduced using a Principal Component Analysis (PCA). The exact number of factors was determined setting a unit Eigenvalue as a cut-off point, and factors were rotated using a Varimax rotation in order to retain orthogonality (table 5). Results identify three shopping motives:

- Social motives: the level at which the individual searches for socially and environmentally distinctive quality signals in their food shopping.
- Ethical motives: the level by which the individual shops for food using ethical and time constraints.
- Consumer motives: the importance given to consumer-specific factors, such as personal taste, low price, and recognisable brands.

Note that these factors are based on self-reported importance, and stated indicators may not represent the real behaviour of the respondent, but only a hypothetical set of motives.

Table 5.
Factor loadings for all products categories

	Social motives	*Consumer motives*	**Ethical motives**
Animal welfare	0.768		
Recognisable brand			
Country of Origin	0.631		
Fair trade	0.726		
Low fat		0.613	
Low salt			
Organic	0.622		
Local	0.706		
Vegetarian			0.674
Low price		0.711	
Low preparation time			0.587
Seasonality	0.618		
Religion			0.834
Personal taste		0.714	
Dietary recommendations			
Recyclable packaging	0.720		
High fiber content			
Fair price for farming	0.730		

Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalisation.
Note: only values over 0.55 are reported in the table

The same approach was used to identify factors from 11 statements on personal beliefs on climate change, and governmental and individual responsibility in dealing with the problem. Results of the three individual factor analyses and the 11 statements are reported in table 6. The factors obtained correspond to:

- Climate change belief: how strongly the person believes in the existence of climate change, and its negative consequences;
- Trust in personal responsibility: how strongly the person supports the importance of personal action and responsibility in tackling climate change;
- Trust in Government responsibility: how strongly the person believes the government is able to successfully intervene and limit the impact of climate change.

Table 6.
Factor loadings for factor 1 in individual and aggregated products categories

	Climate change belief	*Personal responsibility trust*	**Government responsibility trust**
Climate change is a dangerous global threat	0.895		
Humans are responsible for climate change	0.886		
Britain should keep trying to combat climate change, even if other countries do not do so and sometimes cancel out what we do.	0.906		
The effects of climate change worry me, even if their impact is far in the future.	0.893		
It's worth me doing things to help the environment even if others don't do the same.		0.888	
Care for the environment has a high priority compared to other things in my life.		0.847	
I believe my everyday behaviour and lifestyle can contribute to climate change.		0.862	
It is worth being environmentally friendly even if this does not save you money.		0.872	
People have a duty to recycle.		0.852	
The government will take the correct action to support climate change mitigation, if there is adequate information to support that policy.			0.891
Government intervention is the most effective option to combat social problems such as climate change.			0.891

- Extraction method: Principal Component Analysis. Factors have been identified separately

5.3 Sustainable change: Regression results

The underlying motives and beliefs obtained from the factor analysis can be used in the analysis of sustainable improvements through dietary change. The model, as from equation 2, is estimated initially including only factors and instruments, and subsequently adding demographic information. Variables are explained in table 7, presented along with the average of the sample.

Table 7.
Definition of variables

Variables	*Names*	*Description*	**Average (N=1377)**
Dependent variable	change	1=changed choice; 0=otherwise	0.3399
Information	envinfo	Individual asked to view the environmental information provided	0.3856
Treatment	info	Labelling	0.1954
	tax	Subsidy	0.1932
	exprice	Exogenous price change	0.2229
	ban	Ban	0.1881
	removal	Product removal	0.2004
Product	cola	Cola drinks	0.1511
	milk	Milk	0.5265
	meat	Meat	0.1816
	butter	Butter/margarine	0.1409
Problem	cc_belief	Individual believes in climate change and need for action	0.0011
Responsibility	pr_trust	Individual believes in the importance of personal responsibility in tackling climate change	-0.0005
	gv_trust	Individual believes in the ability of the government to tackle climate change	-0.0006
Motive	Socmotive	Individual shops for food looking for social signals	0.0002
	Ethmot	Individual has time and ethical motives when shopping for food	-0.0003
	Consmot	Individual shops with consumerist perspective	0.0000
Demographic	age	Age	37.3435
	lninc	Natural log of income	3.2265
	noinc	No income reported	0.1351
	hh_chil	Children in the household	0.6376
	nsec_prog	Social class - 15 highest, 1 lowest	6.5802
	hdi2007	Human development index (2007) of the country of origin	0.9005
	male	1=male; 0=female	0.3784
Education	_ledu_1	Non-university education	0.3929
	_ledu_2	University level education (including BSc equivalent qualifications)	0.4118
	_ledu_3	Postgraduate level education	0.1954
Newspaper	_lnews_1	1=Mail, Express, Sun, Star (hard right, UKIP, BNP, Cons);	0.3704
	_lnews_2	2=Telegraph (staunch conservative);	0.0414
	_lnews_3	3=Neutral (locals, freebies);	0.2832
	_lnews_4	4=Times, FT (liberal conservative);	0.1118
	_lnews_5	5=Guardian, Indpt, Mirror (left, Labour, Lib Dems);	0.1932
Marital status:	_lmarital_1	Single	0.4808
	_lmarital_2	Married	0.4292
	_lmarital_4	Living with partner, cohabiting	0.0327
	_lmarital_5	Divorced/separated	0.0232
	_lmarital_6	Widowed	0.0080
	_lmarital_7	Engaged	0.0065
	_lmarital_8	generic relationship	0.0196
Location	_llocation_2	Walthamstow	0.0959
	_llocation_3	New Barnet	0.0712
	_llocation_4	Edgware	0.1678
	_llocation_5	Chiswick	0.2041
	_llocation_6	Merton	0.2861
	_llocation_7	Lewisham	0.1750
Constant term	_cons	Intercept	

Instruments are measured relatively to the exogenous price change. This baseline treatment represents the case in which change toward sustainable consumption is purely market-led, and not induced by governmental intervention. Consequently, the intercept would indicate the individual propensity toward change, and it would represent the condition where consumers would switch "naturally".

Results (table 8[§§§]) indicate that labelling treatment has the same impact of an exogenous price treatment. Consequently, the use of private capital achieves the same scope that mechanisms that self-adjust the market to incorporate external costs of consumption. Unsurprisingly, both product removing all polluting options (ban and exogenous removal) are the most effective tools for inducing change toward sustainable consumption. The availability of substitute products enables consumers to switch when their first choice is strictly unavailable. Odds ratios (table 9) show that a ban has a higher impact than an exogenous product removal, providing evidence of motivational crowding-in (see Perino et al., 2011, for more detailed information). Subsidisation has a negative impact on change, providing evidence of motivational crowding-out (Perino et al., 2011).

Results clearly show that self-reported shopping motives, trust and beliefs play no role in changing toward sustainable consumption. Environmental economics predicts that individual response would be positively related to the belief in climate change (Kaiser et al., 1999), to trust in personal responsibility in dealing with the problem (Straughan and Roberts, 1999), and higher for consumers who shop with social motives in mind (Kaiser et al., 1999). The non-significance can be due to the fact that those factors are not important, but more likely these are due to the hypothetical question presented to consumers. Consequently, consumers portrayed themselves as socially conscious independently on their real shopping behaviour.

Contrary to expectations, reading the environmental information had no positive impact change. This is not due to the ineffectiveness of information, but rather because those who read it already had information about it, or had an unobservable higher predisposition to change (i.e. they would have changed independently on the information). Finally, the inclusion of demographic variables indicates that individual characteristics of the respondent have little influence on change. In particular, change is stimulated only by readership of moderate newspapers, while the number of children tends to have a negative impact on the decision to improve the sustainability of the diet.

[§§§] The regression is estimated only on initial polluting purchases.

Table 8.
Logit estimation of change as function of shopping motives, trust and beliefs, and demographics - All products pooled

	Motives, and trust		**Motives, trust, and demographics**	
	Coefficient	*S. E.*	*Coefficient*	*S. E.*
Intercept	-0.5068**	0.2386	0.8823	0.8381
Read environmental information	0.2028	0.1574	0.2138	0.1608
Labelling	-0.0553	0.2496	0.0039	0.2455
Tax	-0.5839**	0.2625	-0.5694**	0.2686
Exogenous price change	reference		reference	
Ban	2.4819***	0.2282	2.5657***	0.2306
Exogenous product removal	2.1787***	0.2196	2.2788***	0.2194
Social motives	-0.0110	0.0833	-0.0446	0.0846
Consumer motives	0.1152	0.0803	0.1105	0.0828
Ethical motives	0.0638	0.0751	0.0747	0.0799
Belief in climate change	-0.0372	0.1606	-0.0089	0.1583
Trust in personal responsibility	0.0967	0.1588	0.0767	0.1597
Trust in government responsibility	-0.0192	0.1239	-0.0388	0.1245
Cola	reference		reference	
Milk	-1.8419***	0.2101	-1.8526***	0.2161
Meat	-1.0326***	0.2396	-1.0533***	0.2486
Butter	-0.7912***	0.2520	-0.8271***	0.2589
Age			0.0031	0.0071
ln(income)			-0.1174	0.1216
Single			reference	
Married			0.0672	0.1686
Living with partner, cohabiting			-0.0643	0.4949
Divorced/separated			0.0787	0.3911
Widowed			-0.3857	0.6175
Engaged			0.2198	0.6328
Unspecified relationship			0.2317	0.6172
Walthamstow			reference	
New Barnet			-0.4878	0.3858
Edgware			-0.4835	0.3371
Chiswick			-0.3708	0.3450
Merton			0.0714	0.3120
Lewisham			-0.2894	0.3557
HDI			-0.9988	0.6918
Social class			-0.0100	0.0206
Mail, Express, Sun, Star (hard right, UKIP, BNP, Cons)			reference	
Telegraph (staunch conservative)			-0.2553	0.3788
Neutral (locals, freebies)			0.0385	0.1952
Times, FT (liberal conservative)			0.5121*	0.2650
Guardian, Indpt, Mirror (left, Labour, Lib Dems)			0.4671**	0.2192
Non-university education			reference	
Graduate education			-0.1217	0.1867
Postgraduate level education			-0.1909	0.2259
Number of children			-0.1445*	0.0764
Number of observations	1377		1377	
Wald $chi^2(14)$	266.22***		306.25***	
d.f. chi^2	14		36	
Log pseudolikelihood	-658.60		-644.52	
Pseudo R^2	0.2538		0.2697	

The regression is clustered by individual consumer. Significance of coefficient as follows: * = 10%, ** = 5%; *** =1%. Columns 3 and 5 report robust standard errors.

Table 9.
Odds ratio by instrument

Instrument	*Motives, and trust*	*Motives, trust, and demographics*
Labelling	-5.38%	0.39%
Subsidy	-44.23%**	-43.41%**
Exogenous price change	Reference	Reference
Ban	1,096.44%***	1,201.01%***
Exogenous removal	783.49%***	876.48%***

Significance of coefficient as follows: * = 10%, ** = 5%; *** =1%.

6 Final Remarks

After the industrial revolution, pollution has been increasing steadily, leading to an increase in the levels of GHG emissions in the atmosphere. The side effect of this process has been an increase in the world's temperature, a phenomenon called Global Warming, which has been associated to change in climatic conditions on the Earth: Climate Change. Consumption of food and agricultural plays an important role in household production of GHG, and policies aiming to improve sustainable development should address the problem of dietary change.

In this paper, we address the problem using an consumer experiment that simulates different policy instruments (labelling, tax, ban, exogenous price change and exogenous product removal). Respondents were customers of a large retail chain in the Greater London area, and were buying beef, cola in cans, whole or semi-skimmed milk, and butter. Each consumer was randomly allocated to a specific treatment, and given a chance to change their initial choice to environmentally friendly substitutes (respectively chicken, cola in plastic bottles, skimmed milk, and margarine).

Results indicate that the most effective policies are those that completely remove the polluting alternative. Albeit this approach may be difficult to implement in real life, decrease in the supply of environmentally unfriendly options has been seen in certain markets: some beer producers have started using plastic bottles (Stella Artois); other companies have focused on reducing the availability of packaging (e.g. Kenco instant coffee).

While the nationwide implementation of a ban might be cumbersome, local bans similar to smoking ban in public places could be effective. This would entail banning cans over plastic bottles of soft drinks in vending machines, or banning whole milk in public procurement. Although difficult to design, this has been effective in markets with public health externalities (e.g. smoking bans, trans-fat bans, or substantial reductions of unhealthy food in school canteens).

More surprisingly, subsidisation of the cleaner alternative proved ineffective. This is a specific case of crowding out of intrinsic motivations (see e.g. Perino et al., 2011). Here, consumers associate a price to the environment that justifies overconsumption (i.e. they pay for the damage), removes desirable social signals (i.e. helping the environment without a return), and increases feelings of unfairness due to governmental intervention. The same does not seem to arise in the presence of an exogenous price change.

Labelling remains a very viable approach. Improving the informational content of a product helps consumers with environmental concerns to act according to their interests, learning about the different environmental impact of products and favouring competition on GHG emissions. Sustainable change is also easier when alternatives differ only in their packaging, and the interaction between labelling and packaging looks a very promising area of future research.

The propensity to change tends to not be influenced by stated shopping motives and beliefs about climate change, while demographic characteristics play a minor role in the choice of accepting dietary change. This suggests that the policy context and the characteristics of the product are the leading factors to reach large scale dietary change.

The paper has three main limitations. Firstly, it only observes choice, while it does not explore the impact of policies on quantity purchase and on interpurchase time. Similarly, it did not explore whether consumers changed their shopping, or only replaced part of it (e.g. the person wanted to buy 12 cans of cola and bought one bottle and 6 cans). Secondly, it only observed a cross-section of events, being unable to observe whether the change had an impact on the following shopping trips of the respondents. Finally,

it did not observe consumer's trade-offs between health (a private good) and environment (a public good) in their choice of food[****].

Nevertheless, the paper observes that rather than a single policy, environmental improvements in food shopping can be more easily achieved by using different instruments at a time. This would entail for instance banning certain types of packaging or products in certain contexts (schools, vending machines, and so on), while maintaining them available in other context, hence reducing consumption. At the same time, products could be subsidies or tax in areas of particularly high externalities, without informing consumers of the endogenous price change to avoid motivational crowding out. Finally, labelling instruments are particularly important, as they could accompany any instrument used and contribute to the environmental education of consumers.

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