THE IMPACT OF ENVIRONMENTAL RECALL AND CARBON TAXATION ON THE CARBON FOOTPRINT OF SUPERMARKET SHOPPING[1]

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Abstract

This study uses an incentive-compatible experimental online supermarket to assess whether prior environmentally-friendly behaviour outside the store, and whether carbon taxes motivate sustainable consumption. Previous research suggests that past decisions may influence current decisions, for example because consumers compensate morally desirable and undesirable acts (e.g. high-carbon food baskets may follow past environmentally-friendly behaviours) over time; while carbon taxes have been promoted as effective tools to reduce the carbon footprint of food baskets, despite limited empirical evidence. After controlling for past consumption, results show that being required to recall past environmentally-friendly behaviour before shopping led consumers to purchase more sustainable food baskets. Carbon taxation also strongly reduces the carbon footprint of food baskets, showing no interaction with the recall of past behaviours.

Keywords: sustainable consumption; moral licensing; priming; carbon footprint; carbon tax.

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1. INTRODUCTION

This article uses a novel incentive-compatible experimental design involving an online supermarket to study interventions to potentially reduce the carbon footprint of actual food choices. The interest on this research stems from current concerns over the sustainability of current food consumption (e.g. Garnett 2011; Grunert, Hieke, and Wills 2014; McMichael et al. 2007). Carbon emissions from food choices are estimated to account for around 30% of total household greenhouse gas emission in developed economies, with supermarkets capturing a large share of food expenditures (e.g., Panzone, Wossink, and Southerton 2013). As a result, there is increasing recognition that an effective sustainability policy requires the direct involvement of consumers (Dietz et al. 2009; Vandenbergh and Steinemann 2007), and that changes in consumer choices in-store can lead to significant reductions in the carbon footprint of food baskets (Panzone et al. 2016). The specific objective of this research was to test whether the recall of past environmentally-friendly behaviour, and the use of a carbon tax are effective in reducing the carbon footprint of supermarket food shopping. To ensure incentive compatibility, consumers made real choices and actually received the goods they purchased.

An individual's involvement in activities that contribute to environmental protection may be related to her moral identity (Jia et al. 2017), which refers to an individual's propensity to give up personal consumption benefits to the advantage of society. Morality is also assigned to contributions to the public good in the form of low-carbon consumption (Daube and Ulph 2016), with "green" consumers being considered ethical and altruistic individuals (Mazar and Zhong 2010). However, food consumption is cyclical, and consumers repeatedly make choices carrying environmental implications (e.g., in a weekly shopping trip to a store): consumers make multiple moral choices within the same consumption episode (e.g. choosing whether to purchase high-carbon meat or low-carbon meat substitutes, followed by the choice of organic or standard vegetables), as well as across episodes (e.g. purchasing high-carbon meat again this week, after having purchased it last week). Food choices may also be influenced by behaviour in other domains (e.g. purchasing low-carbon food in a supermarket after having saved water in the past week). As a result, consumers are called to manifest their morality over time and over domains, and a dynamic model of moral behaviour might be more effective in describing consumer decisions.

Previous experimental research has typically studied why consumers engage in specific environmentally-friendly behaviours. The study of a single instance of behaviour implicitly

assumes that one decision is sufficient to characterise the environmental preferences of an consumer, who acts consistently in order to reduce the psychological discomfort produced by inconsistent behaviours (Festinger 1962). This personological model of moral behaviour views morality as a stable construct, where moral individuals only engage in moral acts; however, it fails to explain why over time individuals may alternate moral and immoral behaviours (Effron and Conway 2015; Khan and Dhar 2006; Mazar and Zhong 2010; Miller and Effron 2010). For instance, consumers may manifest moral licensing, where "desirable" (e.g. pro-social) acts motivate subsequent "undesirable" acts (Khan and Dhar 2006; Mazar and Zhong 2010); for example, a consumer may feel justified in buying a high-carbon meat product after purchasing organic fruit. Cognitive dissonance can only explain compensatory behaviours in cases where individuals go into "moral debit" following an antisocial act, and then react by doing something desirable: for instance, an initial behaviour causing dissonance (e.g. overconsuming water despite caring for its conservation in Dickerson et al. 1992) may lead people to restore the positive link between environmental attitudes and behaviour (e.g. by shortening their shower) when this inconsistency is made salient.

To allow for a more general representation of moral behaviour, Monin and Jordan (2009) present a dynamic model of self-regulation where morality is driven by the moral self-image of the agent: individuals use past moral behaviour to remove the concern of appearing uncaring in subsequent moral tasks (moral licensing, e.g. Mazar and Zhong 2010; Mullen and Monin 2016); while past immoral behaviour motivates individuals to make reparations in present choices (moral cleansing, e.g. Sachdeva, Iliev, and Medin 2009). This approach views individuals as targeting a certain "morality threshold" that they aim to achieve and maintain. In this view, when facing a moral dilemma, individuals will engage in moral behaviour whenever the perceived moral self-worth accumulated through past choices is below a desired level; and will behave immorally when the perceived moral self-worth is above the desired level. As a result, in this article we analyse consumer supermarket behaviour over a two-week period, exploring the link between in-store and out-of-store environmental behaviour, as well as morality using a dynamic model of behaviour.

A key objective of this study is to experimentally investigate strategies that will encourage environmentally responsible behaviour in a simulated on-line supermarket, similar to Demarque et al. (2015), who studied the impact of presenting normative reference points on the purchase of eco-labelled products. Focusing on carbon footprint as our key behavioural variable, our first manipulation tests whether reminding consumers of recent environmental

behaviour motivates or demotivates subsequent environmental behaviour (measured in terms of the carbon footprint of a food basket). More specifically, the experiment tests whether morality in two different domains (food shopping versus other areas of behaviour) are complements (they co-occur) or substitutes (one comes at the expense of the other) (e.g. Nauges and Wheeler 2017). Previous research suggests that consumers making consecutive decisions within the same consumption episode and targeting different goals, e.g. hedonic pleasure and eating healthily, choose by alternating goals (e.g. Dhar and Simonson 1999; Fishbach and Dhar 2005). However, limited research has focused on environmental goals, and very few have studied behaviour across consumption domains, observing instances of moral licensing (Tiefenbeck et al. 2013) as well as consistency (Greenberg 2014).

Our second manipulation explores the role of carbon taxation to drive consistent sustainable low-carbon behaviour in supermarkets. Carbon taxes are often considered a key instrument to reduce global warming as they increase the cost of consumption-driven greenhouse gas emissions (Boardman 2008; Metcalf and Weisbach 2009; Pearce 1991). General work on carbon taxation indicates that it has the potential to reduce household carbon emissions by up to 80% (Metcalf and Weisbach 2009), with particularly strong effects on the consumption of energy (Brännlund and Nordström 2004). In the particular context of food consumption, policy has focused on nutrient-based taxes, targeting directly e.g. alcohol (Panzone 2012), sugar (Zizzo et al. 2016), or fat content (Papoutsi et al. 2015). In contrast, limited research has focused on the impact of carbon taxes on food consumption (e.g. Briggs et al. 2016). As such, a carbon tax would mirror this strategy by taxing a constituent of food products with environmental instead of health implications. Because green taxes are designed primarily to reduce externalities rather than raise revenues, in the experiment we use a carbon tax designed to ensure revenue-neutrality by returning the tax revenues to consumers as income. Note that the carbon tax was announced to consumers, thus potentially sending a signal about the environmental quality of the options under consideration (Hilton et al. 2014).

We also test for the interaction of taxation and environmental recall. In fact, previous research has highlighted that price interventions can influence intrinsic pro-environmental motivation: focusing on grocery, Perino, Panzone, and Swanson (2014) show that subsidising sustainable products can reduce their consumption; similarly, taxes can demotivate ecological behaviour, particularly when considered unfair (see Bowles and Polania-Reyes 2012; Rode, Gómez-Baggethun, and Krause 2015). As such, the literature indicates that a tax can crowd in motivation by signalling the importance of sustainability in the mind of the policymaker, as

well as crowd out motivation by removing the ability to self-signal interest in pro-social behaviour (Bowles and Polania-Reyes 2012; Gneezy, Meier, and Rey-Biel 2011).

The rest of the article is as follows. The next section discusses the model of dynamic moral self-regulation, and consumer behaviour used in the analysis. This section also explains how the experimental treatments can be used to increase consistency in the purchase of low-carbon baskets. Section 3 describes the data collection method. Section 3 presents the results of the econometric analysis. Finally, section 4 discusses the implications of the results for policy and academia, while section 5 briefly concludes this article.

2. DYNAMIC MORAL SELF-REGULATION, ENVIRONMENTAL TAXATION, AND CONSUMER BEHAVIOUR

This section sets out a simple model of consumer behaviour when individuals care about both the direct hedonic pleasure and the environmental impact of the goods they buy. The section starts with a standard one-period model of moral consumer behaviour, which is then extended to a multi-period model of moral behaviour. The section will then continue by contextualising the theoretical implications of the experimental treatments, also identifying testable hypotheses in an econometric model of demand for carbon emission.

2.1. A one-period model of moral consumer behaviour

Consider a consumer i with characteristics D_i. During a weekly shop for food, the consumer is faced with a choice of $j = 1,\ldots, J$ products, which differ in their carbon footprint c_j, and kilocalories z_j,, and other observable characteristics, e.g. brands (which are omitted for simplicity). Goods are sold with market prices $p = (p_1, \ldots, p_J)$. The consumer faces a budget constraint, which is represented by the consumer's overall expenditure limit, E, so that

$$\sum_j x_{ij} p_j + w_i = Y_i + w_i = E_i \qquad (1)$$

where Y_i are in-store expenditures, w_i is the outside good, which for simplicity has a unit price, and x_{ij} is the quantity of good j purchased. Apart from the direct utility the consumer derives from consuming x_{ij}, the consumer gains utility from: a) the morality of consumption, in particular the environmental impact of a good (e.g. Cornelissen et al. 2008; Mazar and Zhong 2010), which is negatively related to the carbon footprint c_j; and b) the healthiness of consumption, whose impact is also negatively related to the indicator variable z_j. The variables

c_j and z_j are measures of damage to the environment and health respectively caused by a unit of consumption of good j

Similar to a moral bank account, the consumer can earn moral credits by engaging in activities that protect the public good, and consume them in activities that damage it. The flow of environmental and health benefits the consumer derives from consumption are defined as

$$m_i = m_{0i} - \sum_j x_{ij} c_j \quad (2)$$

$$h_i = h_{0i} - \sum_j x_{ij} z_j \quad (3)$$

Equation (2) indicates that in a *static* model of moral behaviour, an individual i's self-worth (measured in units of carbon footprint) corresponds to the moral credits earned in all other areas of behaviour, m_{0i}, minus the credits lost by the carbon footprint $\sum_j x_{ij} c_j$ of the individual's consumption choices. Equation (3) replicates this process for health considerations for completeness. However, health credits have private implications and do not impact the moral self-image of the consumer, and are not our focus.

In a complex basket formation task, the resulting objective of the consumer is to determine the quantity of each product j to purchase, x_{ij}, by maximising the utility function (Hanemann 1984; Manchanda, Ansari, and Gupta 1999; Nair, Dubé, and Chintagunta 2005)

$$U_i(x_{i1}, x_{i2}, \dots, x_{iJ}, m_i, h_i, w_i)$$

subject to the usual budget constraint (1), as well as the moral and health constraints (2) and (3). The total carbon footprint demanded by consumer i can now be written as

$$C_i = \sum_j c_j x_{ij} \quad (4)$$

2.2. A multi-period model of moral consumer behaviour

The model presented in the previous section refers to a moral self-regulation process in which the individual cares about the *flow* of moral self-worth. The model becomes dynamic if the individual cares also about the overall *stock* of moral self-worth that he builds over time to shape his moral self (Bénabou and Tirole 2011; Mullen and Monin 2016; Zhong, Liljenquist, and Cain 2009). Following Ulph, Panzone and Hilton (2017), suppose, as in equation (2), that consumption decisions in a given period t, x_{ijt}, generate the current *flow* of moral self-worth as

$$m_{it} = m_{0it} - C_{it} \quad (5)$$

Also, suppose that an individual's *stock* of moral-worth at the start of period t is denoted by M_{it}, and that stock at the start of period t+1, M_{it+1} depends (positively) on the stock of moral credits at the start of period t, the moral credits earned in period t from other activities, $m_{0i,t}$, and (negatively) from current consumption of carbon emissions, $C_{i,t}$, as

$$M_{it+1} = \varphi M_{i,t} + m_{0i,t} - C_{i,t} = \varphi M_{i,t} + m_{it} \quad (6)$$

where $0 < \varphi < 1$ captures the fact that the past stock of moral self-worth loses salience over time (see e.g. Conway and Peetz 2012), for instance by forgetting relevant past behaviour.

Current decisions take account of both the flow of moral self-worth, as represented by the utility function $U(.)$, and the future well-being, as represented by the value function V, as

$$V_i(M_{it}) = \max_{x_{it}}[U_i(x_{it}, m_{it}, h_{it}, w_{it}) + \delta V_i(\varphi M_{it} + m_{it})] \quad (7)$$

where $0 < \delta < 1$ is the intertemporal discount factor. Assuming separability of the utility function to eliminate cross-price effects, the utility function can be written as

$$U_i(x_{it}, m_{it}, h_{it}, w_{it}) = \sum_j U_{ij}(x_{ijt}) + \omega_m U_{im}(m_{it}) + \omega_h U_{ih}(h_{it}) + w_{it} \quad (8)$$

where ω_m (ω_h) is the weight the individual gives to well-being from moral self-worth (health) relative to the direct utility from the consumption of the goods[2]. This approach inherently assumes full separability of any consumption outside the experimental design to the extent that consumers are expected to obtain the same utility from items consumed in the experimental store as well as outside of it. The interventions below have been designed to influence consumer behaviour by affecting the parameters of equation (7) and (8), as described next.

2.3. Making current moral self-worth dynamic: Environmental recall as an environmental nudge

A first treatment gives an unexpected exogenous shock of size θ_i to the individual's flow of moral self-worth m_i, which occurs prior to the individual choosing consumption. The flow of moral self-worth changes as a consequence as

[2] It is perhaps worth noting that if we defined: $\widetilde{U}_{it}(m_{it}) + \delta V_i(\rho M_{it} + m_{it})$, then there would effectively be no difference between the static one-period model in section 2.1 and the dynamic model in this section.

$$m_{it} = m_{0it} - C_{it} + \theta_{it}$$

with a resulting stock

$$M_{it+1} = \varphi M_{i,t} + m_{0i,t} - C_{i,t} + \theta_{it}$$

The values of m_{0it} and θ_{it} are known at the time of the decision on C_{it} at any time t for individuals in this treatment. This shock can, in theory, be positive or negative. However, this section focuses on a positive and exogenous shock, which is the case of our experiment. Then the parameter θ_i gives a temporary boost to moral self-worth, which can be seen as a windfall in moral credits that the individual suddenly finds in his moral credits account.

There are two possible effects of this shock. The first, direct, effect is that this increase in the flow of moral self-worth *licences* the consumer to reduce the amount of effort allocated to current moral consumption[3] (moral licensing, see Khan and Dhar 2006). This direct effect is then expected to increase the carbon footprint of a basket in response to an exogenous increase in the flow of moral self-worth (a negative initial shock would instead result in moral cleansing, see Sachdeva et al. 2009, with a subsequent reduction in the carbon footprint of the basket). As Ulph, Panzone and Hilton (2017) show, this offsetting licensing effect will be *less* than the shock itself, leading to an overall increase in the flow of moral self-worth, which in the dynamic model will also increase the future stock of moral self-worth, M_{it+1}. A second, indirect effect is that the shock could self-signal the individual's commitment to the moral goal (Baca-Motes et al. 2013; Fishbach and Dhar 2005; Gneezy et al. 2012), priming greater compliance with the moral goal, as observed in other contexts where pro-social priming or framing has been applied (e.g. Cookson 2000; Elliott, Hayward, and Canon 1998; Liberman, Samuels, and Ross 2004). In the model, this effect operates by increasing the weight the consumer assigns to the moral component of the utility function, ω_m as a consequence of the shock, i.e. $\frac{\partial \omega_m}{\partial \theta_{it}} > 0$. This commitment effect moves in the opposite direction to the licensing effect, reducing in the carbon footprint of the basket. This leads to a first set of hypotheses:

H_{1a}: *An exogenous shock to moral self-worth increases the carbon footprint of an individual's shopping basket (moral licensing effect) if it raises the moral self-image of an individual, so that* $\partial C_i / \partial \theta_i > 0$.

[3] This would be the only strategy in the case of a static model of morality.

H_{1b}: An exogenous shock to moral self-worth reduces the carbon footprint of an individual's shopping basket (moral consistency effect) if it influences the perceived importance assigned to morality, so that $\partial C_i / \partial \theta_i < 0$

2.4. Raising the costs of carbon: Carbon taxation as a tool for reducing the consumption of carbon emissions

Carbon taxes are often advocated as an option to reduce the carbon footprint of baskets by incorporating the external costs of carbon footprint into the price of the good. The role of price instruments in changing behaviour is based on the general premise that price changes force consumers to reallocate their budget from the now more expensive (e.g. taxed) options to cheaper ones. The tax treatment increases the marginal price of the carbon footprint by a value T equal to the rate of the tax per unit of carbon footprint, to that the price of all goods p_j is increased by $\tau_j = Tc_j$. Notably, taxation inevitably induces both price effects, whereby consumers shift to low CO_2 equivalent (CO_2e) products,[4] which are now relatively cheaper (due to a lower tax), as well as income effects, as consumers buy less because the tax reduces their disposable income. A redistribution mechanism embedded into the treatment removes these income effects by returning total revenues from the tax, $\sum_j \tau_{ij}$, in equal shares to all consumers.[5] Consequently, the manipulation refers only to price effects. In addition, our combined tax and redistribution manipulation mirrors the fact that green taxes are normally designed to induce changes in behaviour that benefit the environment, but not to raise additional revenue for the government, and so are designed to be revenue-neutral, by using offsetting reductions in other taxes.

Apart from a standard direct effect, where the tax reduces consumption by raising market prices, the tax can also have an indirect behavioural effect: the mere presence of a tax can have psychological effects that can reinforce or diminish the pure economic effect of this policy instrument (see e.g. Sunstein and Reisch 2014). For instance, knowledge of the tax might

[4] In the remainder of the article, the carbon footprint will be reported in terms of carbon dioxide equivalent (CO_2e). Specifically, the carbon footprint consists of carbon dioxide (CO_2) as well as other gases that affect the atmosphere (CFCs and methane, for instance); the carbon footprint converts the damage caused by these gases into the amount of CO_2 needed to cause the same damage, and adds all the gases into a single metric, known as CO_2e. gCO_2e stands for grams of carbon dioxide equivalent.

[5] Note that, because the taxation is by construction higher than the fraction that is returned via the redistribution mechanism, this remains a genuine price manipulation as opposed to a purely psychological one.

trigger psychological tax aversion (Sussman and Olivola 2011) and lead to an additional purely behavioural response that reinforces the direct price effect and reduces the consumption of undesirable (and taxed) goods (e.g. Zizzo et al. 2016). At the same time, taxes signal "good" and "bad" products to consumers, and by doing so they can activate social preferences that lead to a stronger effect than that of the price change alone (Bowles and Polania-Reyes 2012). Imposition of a tax can also lead to paradoxical effects, increasing rather than decreasing intentions to consume carbon (Hilton et al. 2014). However, our experimental design does not allow isolating pure price effects from pure behavioural effects of carbon taxation, which is not in the remit of this article; in practical policy applications, the two sets of effects are likely to occur in combination. The second working hypothesis is that

H_2: A revenue-neutral carbon tax will reduce the average carbon footprint of baskets by increasing the marginal price of carbon footprint in the basket.

2.5. The interaction between price interventions and a moral self-esteem shock

A consumer's response to taxation may depend on the amount of environmental self-worth the individual holds. In general, for a consumer who assigns a higher value to environmental preservation (and hence has a higher implicit price for a good) a given environmental tax will represent a smaller proportionate increase in the implicit price than an individual with a lower value for environmental preservation, and so the tax would be expected to have a greater impact on the latter baskets. Nevertheless, in general an increase in moral self-worth would be expected to reduce the sensitivity to a carbon tax: a sudden (and free) increase in the amount of moral credits owned from a positive self-worth shock θ_i should reduce the demand for further moral behaviour (e.g. Mazar, Amir, and Ariely 2008), therefore reducing the need to respond to a tax requesting a reduction in the carbon footprint of a basket. Alternatively, there could be a negative interaction between tax and recall: the imposition of a carbon tax may remove the impact of environmental recall on pro-environmental identity because consumers no longer attribute the cause of a low-carbon basket to preferences for sustainability, but to a desire to minimise the tax paid (e.g. Perino et al. 2014; Zuckerman, Iazzaro, and Waldgeir 1979) – as in the forced-constraint treatments of dissonance experiments (see discussion in Hilton et al. 2014). According to this second effect, the tax might remove the psychological link between the environmental impact of food choices and other behaviours, moving the impact of environmental recall towards zero. These effects lead to a third set of testable hypotheses:

H_{3a}: The increase in moral self-worth reduces the sensitivity to a carbon tax, increasing (ceteris paribus) the carbon footprint of the basket relative to a tax alone.

H_{3b}: If taxation removes the moral self-attribution of pro-environmental behaviour, the presence of a carbon tax can remove the impact of environmental recall on the carbon footprint.

2.6. Specification of the model to be estimated

The utility-maximisation process identifies the optimal consumption of carbon footprint in the basket, C_{it}, as from equation (4). This carbon footprint depends on a vector of individual characteristics D_{it} (which includes the current credits from other past environmentally-friendly behaviours, m_{0it}), and on the experimental treatments $I_i \equiv [\theta_{it}, T_{it}, T_{it}\theta_{it}]$, where θ and T refer, respectively, to the moral self-worth shock and the carbon tax. The demand for carbon footprint is specified using the log-linear regression

$$ln(C_{it}) = \alpha_t + \beta_t D_{it} + \gamma_t I_{it} + \varepsilon_{it} \quad (9)$$

where $\gamma \equiv [\gamma_\theta, \gamma_T, \gamma_{T\theta}]$. The list of hypotheses above entails the following: a moral licensing effect (H_{1a}) implies $\gamma_\theta > 0$; a moral consistency effect (H_{1b}) would imply $\gamma_\theta < 0$; a successful carbon tax (H_2) would require $\gamma_T < 0$; if the moral self-esteem shock reduces the effectiveness of a tax (H_{3a}), then $\gamma_{T\theta} > 0$; If taxation removes moral self-attribution (H_{3b}), then $\gamma_{T\theta} < 0$.

Because interventions are week-specific, carbon emissions in week 2 can be written as

$$ln(C_{i2}) = \alpha_2 + \beta_2 D_{i2} + \gamma_2 I_{i2} + \varepsilon_{i2} \quad (10)$$

Residuals ε_{i2} may contain unobservable preferences for low-carbon baskets that can add variance to the estimate and cause problems of endogeneity in the regression. Following Bajari et al. (2012), these unobservable preferences can be differenced out by assuming residuals follow a first-order Markov process, so that

$$\varepsilon_{i2} = \rho\varepsilon_{i1} + \upsilon_{i2} \quad (11)$$

To this extent, carbon emissions at week 1 correspond to

$$ln(C_{i1}) = \alpha_1 + \beta_1 D_{i1} + \varepsilon_{i1} \quad (12)$$

After isolating ε_{i1} in equation (12) and replacing it in equation (11), equations (10) becomes

$$ln(C_{i2}) = \alpha_2 + \beta_2 D_{i2} + \gamma_2 I_{i2} + \rho[ln(C_{i1}) - \alpha_1 - \beta_1 D_{i1}] + \upsilon_{i2} \quad (13)$$

which, assuming a constant intercept, can be re-written as the estimable equation

$$ln(C_{i2}) = \alpha(1-\rho) + \beta_2 D_{i2} - \rho\beta_1 D_{i1} + \gamma_2 I_{i2} + \rho\, ln(C_{i1}) + \upsilon_{i2} \quad (14)$$

In equation (14), the coefficients γ_2, β_2 and ρ are estimated directly; the coefficients α and β_1 are instead obtained from the regression parameters by dividing them, respectively, by $(1-\rho)$ and ρ. For time-invariant variables within D (e.g. demographics), β_1 can be identified only by assuming constant coefficients ($\beta_1 = \beta_2 = \beta$), and diving the resulting estimate by $(1-\rho)$.

3. DATA AND EXPERIMENTAL DESIGN

A total of 260 students were recruited to participate in an online shopping experiment. They were paid a £5 fee purely for their time, and were assigned a £25 weekly budget to shop in the store for two consecutive weeks. The online shop presented consumers with 665 food and (non-alcoholic) drink products currently available in Tesco stores (Figure 1). A key criterion for inclusion of products in the store was the availability of an actual full (i.e. pre-discount) price in Tesco stores, carbon footprint (in CO_2e), and nutritional facts (kcal, and grams of selected macronutrients) for each item. The store uses existing products from Tesco[6], which have actual carbon footprint measures from a single source and for a wide range of products, covering all the categories of interest of the participants of the study[7]. Participants were informed at the start that they could spend as much as they wished in store, and any unspent budget was then added to their participation fee and given to them at the end of the experiment. To ensure incentive compatibility, participants were given the goods they had purchased in one of the two weeks of shopping (chosen randomly at the end of the experiment). Collection worked as a "click-and-collect" scheme: participants would come and collect their baskets and their compensation the week after the end of the experiment. Of the 260 participants recruited, 235 participated in the first week of shopping, and 230 participants returned in the second week.

3.1. Experimental design

[6] The dataset initially consisted of the products in the list available at https://www.tescoplc.com/assets/files/cms/Tesco_Product_Carbon_Footprints_Summary(1).pdf. Tesco kindly provided further information on products that were footprinted after this document was published online.
[7] A pre-survey and a survey pilot identified which products the target population purchased more frequently.

The experimental design consisted of a 2 (environmental recall vs no environmental recall) x 2 (carbon tax vs no tax) orthogonal between-participants experimental design for 199 participants. The experimental design is shown in Figure 2. In each experimental week, participants completed the following steps (in the exact order): they reported their perceived environmental self-image (from Jordan, Mullen, and Murnighan 2011); they shopped; and completed a questionnaire on their attitudes and beliefs on the importance of the environment, and their socio-economic characteristics (only in week 1). A fifth "no-self-image" group (31 individuals) was included as a second control to test whether the environmental self-image question had a priming effect on participants; in this treatment, there was the after self-image question before shopping in both weeks. Week 2 was the same as week 1 for each treatment with the following two exceptions:

a. An *environmental recall manipulation* was implemented in the two treatments with environmental recall: consumers started by completing a questionnaire that asked them to report how frequently they had performed a number of pro-environmental behaviours in the previous week, which were then converted into carbon savings that were notified to participants (see section 3.1.1 for details). Consumers answered the environmental self-image question after filling this questionnaire, and then shopped.
b. A *carbon tax manipulation* was implemented in the tax treatments: a carbon tax was introduced and changed food prices proportionally to the carbon content of a food product (all tax revenue was redistributed; see section 3.1.2 for details).

3.1.1 Environmental recall manipulation

The environmental recall treatment aimed to raise the perceived moral self-worth of participants. Here, consumers were asked to indicate the frequency over the last seven days of a number of environmental behaviours shown in Table 1 below, using a questionnaire that requested:

> *"Please pause one moment and think about the activities you have done in the past week (i.e. in the past 7 days) to help protect the environment for you and for others. How often have you done any of these during the last week?*

Carbon savings available in the second week of shopping were estimated for each of these behaviours on the basis of published data to determine the total amount of CO_2e saved by each

participant over the past week. Straight after completing this questionnaire (therefore before entering the shop and reporting their environmental self-image), participants were notified that

> *"CONGRATULATIONS! Over the last seven days you have saved [estimated CO_2e saved] grams of CO_2e".*

This approach allowed consumers to recall socially desirable acts they performed in the recent past, while quantifying the social benefits of such acts using a carbon footprint metric. Participants who were not in an environmental recall treatment filled the environmental recall questionnaire at the end of the week 2 survey, and were not notified of their carbon savings.

3.1.1. Carbon tax manipulation

In the first week of the experiment, the prices of the goods reflected the exact prices consumers would find in Tesco stores (removing all discounts). These prices did not change in the second week for those participants in the control and the environmental recall treatment. In the second week, participants in both treatments with a carbon tax were presented with prices that reflected the carbon content of the products available in store. This carbon tax, measured as the CO_2e content of each product multiplied by a £70/tonne of CO_2e (in line with estimates from DECC 2016), was added to the baseline price, which on average raised food prices by 8.47%. To ensure the visibility of the carbon tax, consumers were presented with full prices (i.e. inclusive of the tax), with the addition of a line below the price indicating "This price includes £[value] of carbon tax" (see Figure 1 above). For the reasons discussed in section 2.4, total tax revenues were redistributed to participants in the two treatments with a carbon tax, who were reimbursed by the average tax paid. Participants were clearly notified of this redistribution before the shopping task.

3.2. Measuring carbon footprint of baskets

As discussed in section 1, sustainable consumption of the consumer in each weekly shopping episode is measured in terms of the carbon footprint of the basket in grams of CO_2e, to circumvent problems of aggregation of products that can differ noticeably in product quality. Econometrically, this represents the consumer demand for carbon footprint. Similarly, as already noted above, the frequency of the behaviour from the environmental recall questionnaire reported in Table 1 was converted into grams of CO_2 equivalents saved in the

previous week by engaging in the environmental activities. This meant that a person's moral self-worth was measured in the same metric as the environmental impact of the basket.

4. RESULTS

This section presents the experimental evidence of the impact of environmental recall and carbon tax on consumer behaviour. Results indicate that a carbon tax is very effective in reducing the carbon footprint of food baskets, with estimates that are robust to variable choice and model specification; the requirement to recall of past environmental behaviours is also associated with a reduction in carbon footprint, with estimates that are again robust across regressions, although significance can change depending on the regression specification. The two effects are similar in magnitudes, so that a moral recall task provide reductions comparable to those of a £70/tonnes CO_2e tax. The two treatment manipulations do not interact significantly. In presenting these results, we begin by introducing the characteristics of the sample, with a particular focus on carbon consumed and saved, and consumers' environmental self-image. These initial steps are then followed by a regression analysis to test our experimental hypotheses (as spelled out in section 1.5 above).

The analysis below also uses a number of constructs from the literature on moral and prosocial behaviour. The first item is an "environmental identity" scale adapted from the moral identity scale of Aquino and Reed (2002) by focusing only on "environmentally-friendly" as the moral attribute being assessed (see online appendix 2).[8] A second item is the short Social Desirability Scale (Stöber 2001), which measures the extent to which an individual behaves pro-socially (see online appendix 2). A third item is the intertemporal discount rate (IDR), which measures the importance given to future consumption: IDR was calculated asking consumers to indicate their WTP for compensation to wait to use a £50 money voucher for one year (Zauberman et al. 2009), with the IDR calculated as $r = \frac{\ln\left[{}^{(50+WTP)}/_{50}\right]}{1}$. Knowledge of product carbon footprint was measured as the sum of correct answers to eight questions asking participants to identify high carbon options within a pair of goods. Finally, following Cornelissen et al. (2008), we measured pro-environmental attitudes (how consumers feel about environmental behaviours), moral obligation (the extent to which consumers feel morally

[8] A principal component analysis yielded the same two factors of the original scale (online appendix 2): internalisation, which measures how central environmental identity is to the self-concept of the consumer; and symbolisation, which measures how much the respondent believes his actions reflect this identity.

obliged to protect the environment), and self-perception (how environmentally-friendly consumers perceive their actions to be) (see online appendix 1).

4.1. Descriptive statistics

The experiment collected information on 199 participants allocated to the main experiment, plus 31 consumers in the no-self-image control. Table 2 shows the demographic breakdown of all treatments: apart from the share of British nationals, participants did not differ significantly across groups. In comparing baskets across weeks, Table 3 also shows that consumers spent the same amount of money in both weeks; however, the carbon footprint in the basket dropped in all treatments, suggesting that consumers substituted lower-carbon goods, with the largest drop in total carbon footprint when both the tax and the environmental recall treatment manipulations were presented jointly. Albeit non-significant, the drop is unexpected for the control treatment, and could be driven by the participants learning about the environmental focus of the experiment or the environmental quality of the goods, changes in their own inventories, as well as by external factors unobservable to the econometrician (e.g. news on the media). The environmental self-image of the consumers also did not vary significantly as a result of the main treatment manipulations.

4.1.1. Consumption of carbon footprint across weeks

Table 3 shows that all experimental treatments witness a reduction in carbon footprint in week 2 baskets. This point is represented graphically in Figure 3 below, which compares the control treatment with self-image to the treatments with experimental manipulations; and in Figure 4 below, which compares the two control treatments. These graphs show that while the control reduced consumption by an average of 1,510 gCO_2e; median drop: 31 gCO_2e), the footprint dropped by 1,404 gCO_2e (median drop: 902 gCO_2e) in the control with the after self-image question, by 2,376 gCO_2e (median drop: 1,309 gCO_2e) in the environmental recall treatment, by 2,854 gCO_2e (median drop: 2,741 gCO_2e) in the tax treatment, and by 4,227 gCO_2e (median drop: 2,659gCO_2e) for the joint manipulations treatment. The net average reduction relative to the control equals 867 gCO_2e for environmental recall, 1,344 gCO_2e for a carbon tax, and 2,718 gCO_2e for a joint manipulations treatment; the control with the after self-image question shows a net increase of 105 gCO_2e relative to the control. A median test reveals that the median drop in carbon footprint of baskets in the control group with self-image question is not different from the control with the after self-image question ($p = 0.548$), but is significantly smaller than that of the environmental recall treatment ($p = 0.088$), tax treatment ($p = 0.015$), and joint recall

and tax treatment (p = 0.003). Importantly, Figure 4 indicates that the presence of the environmental self-image question before the shopping trip did not prime participants into purchasing lower-carbon baskets: consumers who were asked the environmental self-image question before shopping in fact had a non-significantly higher (rather than lower) carbon footprint in their basket in both weeks.

Despite differences in the amount of carbon emissions in baskets across the two weeks, the natural logarithm of the carbon footprint of the baskets in the first and second weeks was strongly correlated in all treatments, with Spearman rank correlation $\rho = 0.83$ ($p < 0.001$) in the control treatment with self-image question, 0.80 in the control treatment without self-image question, $\rho = 0.87$ ($p < 0.001$) in the tax treatment, $\rho = 0.80$ ($p < 0.001$) in the environmental recall treatments, and $\rho = 0.58$ ($p < 0.001$) in the environmental recall + tax treatment. Finally, Kolmogorov-Smirnov tests indicate that the distribution of the natural logarithm of the carbon footprint in the baskets did not change across weeks in each of the treatments.

4.1.2. Estimated carbon savings

All participants in the sample were asked to fill the environmental recall questionnaire of Table 1, aimed at estimating the carbon footprint consumers saved in the past week by engaging in a series of environmentally-friendly behaviours. As explained in section 3.1.1, half of the sample filled a questionnaire just after logging into the online shop, and were shown the estimated carbon savings before shopping; the other half of the sample completed it at the end of the final questionnaire and were not given the estimated savings. In the sample, no participant reported zero carbon savings, with an average value of 13,034 gCO2e (median = 12,202 gCO2e). A Kolmogorov-Smirnov test indicates that the distributions of basket carbon savings in the experimental treatments (shown in Figure 4) did not differ significantly from the control group with self-image question. The estimated carbon savings in the previous week are only weakly correlated with the basket carbon footprint in week 2, with Spearman correlation coefficients not significantly different from zero (control treatment: $\rho = 0.12$, $p = 0.40$; environmental recall treatment: $\rho = 0.15$, $p = 0.30$; tax treatment: $\rho = -0.18$, $p = 0.20$; environmental recall + tax treatment: $\rho = -0.05$, $p = 0.72$). Finally, a non-parametric local polynomial regression (Fan and Gijbels 1996) shows that carbon reported to be saved the previous week and consumed in the current experimental basket may not be related, as their non-parametric relationship is fairly flat (Figure 5); however, there might be a link between these metrics for extremely low or extremely high values.

4.1.3. Environmental self-image

The moral self-image of the consumer can be an important motivator of moral behaviour, because it measures the consumer's perceived distance from a desired level of morality[9] (Monin and Jordan 2009). Following Jordan et al. (2011), environmental self-image is measured as the answer to the question "Compared to the environmentally-friendly person I want to be, I am…", using a 1-9 scale going from "Much less environmentally friendly than the person I want to be" (low self-image) to "Much more environmentally-friendly than the person I want to be" (centre: "Exactly as environmentally friendly as the person I want to be"). As such, we expect a positive correlation between environmental self-image and CO_2e consumption, *ceteris paribus*: holding the target moral stock constant, consumers with low environmental self-image should be expected to build baskets with less CO_2e compared to those who behaved exactly as they wished; these in turn would be expected to put less carbon footprint in their basket compared to those who report doing better than they wish. To ensure the value only referred to the mental state of the consumer *prior to* any purchase, the self-image question was asked before the shopping trip, except for the control with no self-image question treatment, who reported it after the experiment[10]. Table 4 shows that the scores given to the environmental self-image question are positively related to other scales: environmental self-image is related to the symbolization (but not the internalisation) component of environmental identity (as in Jordan et al. 2011), as well as, in some treatments, to self-perception. Self-image is also negatively correlated to the carbon footprint of a basket, but significantly only for participants in the environmental recall and control with social image question treatments in week 2 only, or across the whole sample[11].

To explore the functional form of the relationship between environmental self-image and carbon footprint further, we ran a non-parametric local polynomial regression of degree 3 (Fan and Gijbels 1996). Figure 7a confirms that these two variables are unrelated in all treatments in week 1: their relationship is described by a fairly flat line, and an increase in environmental

[9] A test of internal validity shows that this metric is fairly stable across time period. In fact, the Spearman rank correlations across treatments are as follows: control with social image question = 0.7295, p = 0.000; moral licensing = 0.5859 (p = 0.000); tax = 0.7306 (p = 0.000); moral licensing + tax = 0.3069 (p = 0.032).

[10] The position of the environmental self-image question influenced the response given: participants who answered this question after shopping (the control with the after self-image question treatment) reported a lower self-image compared to the rest of the sample in week 1 ($p < 0.05$ if tested against all treatments; $p < 0.10$ if tested against the control with social image question treatment only), suggesting that the act of shopping in itself made people feel relatively environmentally-unfriendly; the effect is not present in week 2 ($p > 0.10$ when tested against all treatments, as well as when tested against control with social image question treatment only).

[11] The whole sample in this case includes participants in all 5 treatments. The correlation coefficient of the "All sample" column in Table 4 remains significant if the two controls are removed, either individually or jointly.

self-image effectively has no impact on the carbon footprint of the basket. Figure 7b shows that, despite a noticeable increase in variance, these lines remain flat in week 2 with the only exception of the recall treatment: for participants who had to assess their past behaviour (and faced no tax), an increase in environmental self-image reduces the carbon footprint of the basket (though with noise apparent from the upward shift for values of environmental self-image between 6 and 7).

4.1.4. The impact of environmental recall and a carbon tax on the carbon footprint of food baskets

The aim of this section is to estimate equation (14) to test the experimental hypotheses on the impact of environmental recall and carbon taxation on the consumer carbon footprints, as identified in sections 2.3-2.5. Covariates are added progressively to the regressions: a first regression adjusts for treatment dummies only (model A); a second regression adds the CO_2e of the basket in the previous week, to derive an estimate of ρ (model B); a third regression adds demographics (gender, age, British nationality) and carbon saved, which are only measured once (model C); a fourth regression adds psychological variables (e.g. moral identity scales, social desirability scale, and intertemporal discount rate) and knowledge of product carbon footprint (all current and lagged) (model D); and a fifth regression adds the logarithm of total expenditures (current and lagged) (model E). In these regressions, the environmental recall dummy includes all participants in the two treatments with an environmental recall questionnaire; the tax dummy includes all participants in the two treatments with a carbon tax; while the multiplicative interaction term identifies the joint treatment manipulations effect.

A first set of regressions (Table 5) uses the natural logarithm of the carbon footprint in the second week of shopping as dependent variable. However, while some participants might have spent a significant amount of money on price premia to have a full basket with low-carbon options, others might have spent little money hence obtaining a low-carbon basket. To address the problem, a second set of regressions (Table 6) normalises the carbon footprint by the amount of money spent to obtain the ratio C_i/Y_i before a logarithmic transformation. In both cases, these transformations lose one participant who did not buy anything in week 2. Section 4.2.1 compares main effects and interaction effects; in section 4.2, these effects are estimated after progressively adding covariates to the analysis.

Results in Tables 5 and 6 indicate that a carbon tax significantly reduces the carbon footprint of the basket[12], supporting H_2. Environmental recall has a main effect of comparable size and indicates a reduction in carbon footprint, consistent with the direction of H_{1b} rather than H_{1a}. As a result, the presence of the environmental recall questionnaire before the shopping decisions always reduces the carbon footprint of the basket, providing no evidence of a licensing effect; however, the consistency effect (i.e. evidence for H_{1b}) is significant only when individual heterogeneity is controlled for[13]. The joint effect is the sum of the two individual effects, with no significant interaction between them: the results provide no evidence to support H_{3a} and H_{3b}, but rather indicate that carbon taxation does not alter the underlying environmental motivation of consumers who are building a basket. In terms of marginal effects, carbon taxation reduces the carbon footprint of a food basket by 2.2-5.4 kg CO_2e, while environmental recall leads to a reduction of 2-3.3 kg CO_2e[14]. Assuming this shop was representative of an average weekly shop, the average reduction per household is 281 kg CO_2e/year for the carbon tax, and 172 kg CO_2e/year for the environmental recall questionnaire. To put these numbers into perspective, the carbon footprint of one litre of petrol is 3.15 kg CO_2e, and that of one low-energy lightbulb left on continuously for a year is 90 kg CO_2e (Berners-Lee 2011). Finally, the tax increased prices by 8.47% (on average), and reduced carbon emissions by 12-26%, raising £107.65[15]; these figures indicate a tax elasticity of demand for carbon footprint of -1.4 to -3.1, and a reduction of 21-50 gCO_2e/£ of tax earned.

Results further indicate that age and psychological variables do not predict the consumption of carbon footprint in both weeks[16]. Male participants appear to consume less gCO_2e/£ across several specifications, while British nationality only affects total CO_2e consumption before adjusting for attitudes and expenditures. The carbon footprint saved before shopping is also positively related to the carbon footprint in the basket (as expected if moral licensing occurs), with an elasticity of around 0.1-0.2 that is not significant in any of the regressions. Finally, the carbon footprint of week 1 is strongly linked to the carbon footprint of week 2, accounting for a strong habitual component in the generation of carbon emissions from food purchasing. Our results indicate that demographics and attitudes mostly do not have a

[12] The only insignificant coefficient in these tables is slightly above the 10% probability (p=0.164)
[13] The coefficient is close to significant when CO_2e is divided by price, with p = 0.119.
[14] The average carbon footprint in the basket in the first week was 20,312 gCO_2e; the average carbon footprint in the control group in week two was 19.9 kgCO_2e.
[15] The average tax paid by the 99 participants in the tax treatments was £1.09, or 6.8% of their £15.97 spend.
[16] The coefficient of week 1 psychological variables, which are key to the identification of equation (19) are not significant, and are not reported in this sections to keep tables compact.

major impact on sustainable behaviour, as also observed in previous research using actual sales data (Panzone et al. 2016); other than the possible exception of gender, the key factors determining present carbon footprints appear to be past consumption, and experimental stimuli. Part of the lack of significant effects in these coefficients is possibly due to the relatively small sample in the analysis, which limits the efficiency of the estimation due to the unobservable heterogeneity in consumer preferences[17].

5. DISCUSSION

This article explored the impact of recalling previous environmentally-friendly acts and a carbon tax on consumer behaviour in online food retailing. Experimental research has recently observed that recalling past behaviour produces compensatory effects in line with moral licensing (Khan and Dhar 2006; Sachdeva et al. 2009), as well as consistency effects in line with self-perception or dissonance reduction approaches (Dickerson et al. 1992; Freedman and Fraser 1966). A key question addressed by this research is which of these effects appear in complex real life situations where consumers are subjected to a multiplicity of stimuli. In addition, current debates on environmental policy support the introduction of a carbon tax, but there remain questions on the effectiveness of this intervention due to limited research on this topic. This section discusses the implications of our results in light of the existing literature on moral decision-making and carbon taxation.

5.1. The impact of environmental recall on the carbon footprint of a basket

The first element of this discussion is the relation between recalling past environmentally-friendly behaviour and the current carbon footprint of the consumer. As discussed previously, the environmental recall treatment made the amount of the carbon saved in the previous week salient and known exactly (i.e. given the imprecision associated to carbon lifecycle measures). Given the link between present and past carbon footprint (equation (7)), the increase in moral self-worth θ could have been used immediately, causing moral licensing, or could have been stored to raise the stock of pro-environmental self-worth. Results indicate that knowledge of

[17] In a further analysis (available upon request), equation (14) was estimated separately for low vs high carbon savings (defined as above or below the mean carbon savings of 13,034.44 gCO2e), to test whether the relation between past carbon saved on current behaviour might be change slope at different level of consumption (as in Figure 5). Results indicate that consumers with large CO_2e savings have a negative non-significant relation between CO_2e saved and CO_2e consumed, while consumers with small savings present a positive relation, an indication that these consumers might use information on the carbon available to license their behaviour. Moreover, the environmental recall questionnaire and the carbon tax appear to have a much stronger impact on consumers who saved more carbon before shopping in magnitude. However, these coefficients have large standard errors, and are either not significant or the main effects are at best significant at $p = 0.10$.

the amount of carbon saved in the past week reduced the carbon footprint of baskets, an indication that consumers did not view this value as a sort of "carbon allowance" for their consumption. Previous research already noted that moral self-worth shocks do not always lead to moral licensing (Blanken, van de Ven, and Zeelenberg 2015), despite evidence that supports the existence of this effect (see Effron and Conway 2015; Miller and Effron 2010; Mullen and Monin 2016 for comprehensive reviews of the literature). This article contributes to the ongoing debate of whether the recollection of previous pro-environmental behaviour leads to compensatory or consistency effects by finding that environmental recall promotes current pro-environmental behaviour.

It is worth noting our environmental recall questionnaire used a different measure of recall to that used by Sachdeva et al. (2009), where consumers had to write down past pro-social acts in a free recall task. However, the approach used in this research asked consumers to estimate the frequency of pro-environmental behaviours that were presented to them in a list, and might have reminded consumers of how much they had *not* done[18], possibly causing feelings of inadequacy (the conflict between attitudes and behaviours shown in Dickerson et al. 1992). Environmental priming may also have been at work, analogously to how this appears to work in other contexts in inducing pro-social behaviour (e.g. Cookson 2000; Elliott et al. 1998; Liberman et al. 2004). The temporal distance between the time of the choice and the time of consumption might have facilitated consistency: environmental recall could have indeed motivated the search for immediate gratification, which consumers could not satisfy in an online store and satisfied elsewhere (e.g. in another store after the experiment). However, it is worth noting that psychological studies that observe evidence for moral licensing tend to use hypothetical gratification, suggesting that distance between choice and consumption might not be a dominant confounder of these results.

As exposure to the environmental recall questionnaire reduced the average carbon footprint of consumers in the treatment, the amount of carbon saved was not significantly linked to carbon consumed. This result could be driven by the existence of a non-linear (rather than linear) relationship between these two variables: Figure 5 shows that a linear relationship between these metrics might exist only for those consumers who saved very little CO_2e (a positive relationship, i.e. moral licensing), and for those who saved large quantities of CO_2e (a negative relationship, i.e. moral consistency). This effect on extreme values did not appear in

[18] No consumer engaged in all the measured environmental activities (see Table 1).

consumers who had recalled past behaviour. However, the number of participants in this experiment is too low to allow for further analysis on this functional relationship at the extremes of the distribution of carbon savings, something that should be considered in future research. Notably, the literature on moral licensing indicates that moral credentials, but not moral credits, are context-specific (Miller and Effron 2010); however, these results indicate that the carbon footprint from food choices is not seen as clearly mentally relatable to the carbon footprint of non-food items included in the environmental recall questionnaire; in other words, consumers do not see the carbon footprint from different behaviours as perfectly equivalent to the carbon footprint in the food basket.

Equally surprising is the lack of a clear relationship between environmental self-image and environmental behaviour. Theories of moral self-regard view the distance to the ideal moral-self as a key factor in driving moral behaviour (Monin and Jordan 2009). This relation should exist in all treatments (including the two control groups), and should be stronger under psychological stimuli that increase salience of the distance between actual and ideal moral self (as in the recall treatment above), or, more generally, interventions that activate concerns of being below the ideal moral self. However, results fail to find a clear link between environmental self-image and carbon footprint: the rank correlation (Table 4) is significant only for consumers who were reminded of their past behaviour and the control group with self-image question asked before the shopping task (in week 2 only). Similarly, Figures 7a and 7b show that the environmental self-image scale may be negatively related to behaviour only for participants in the environmental recall treatment in week 2, with a functional relationship characterised by a flat line in all other week-treatment combinations. However, given limited statistical power, future research will need to verify the robustness of this result.

5.2. The impact of a carbon tax on the carbon footprint of a basket

A second experimental treatment tested the viability of a carbon tax as a means to reduce the carbon footprint of food baskets. Results indicate that sufficiently high carbon taxes (£70/tonne CO_2e, in line with directives from DECC (2016), and equivalent to an average increase of 8.47% in market prices) are effective in changing consumption to lower carbon footprints. The introduction of the carbon tax showed a significant potential for carbon reduction in a context where expenditures were real, with baskets containing 2-5 kg CO_2e less than the control group (12-25% reductions). This strongly significant effect is fairly stable across model specifications. Because the revenues from the tax were redistributed to participants in the tax

treatment (who were clearly notified before they started shopping), these results purely refer to consumer switching to now cheaper low-carbon options rather than consuming less (no income effects). This reduction might have been facilitated by the easy access to close substitutes in the shop (e.g. smaller sizes of the same good, or low-carbon options); this result might not be replicable in contexts or choice sets where substitution is complex, either because a direct low-carbon substitute does not exist, or because consumers do not perceive an existing substitute as easy to use or consume (e.g. shifting from meat to a vegetarian meat substitute). The effect of the carbon tax also added significantly to the effect of the environmental recall questionnaire. This additional response is summative, not multiplicative: the two effects do not cancel each other, but jointly work in the marketplace; however there is no synergy between them, an indication that consumers do not associate these two stimuli.

In the experiment, the carbon tax was simplified to the extent that it imposed a full pass-through of the tax: the price of the good increased perfectly by the amount of the tax, with no adjustments of the supply side of the market (e.g. Kenkel 2005). If retailers can adjust their prices to absorb part of the price increase (e.g. by switching to cheaper suppliers), then the effect of the tax would be lower than we observed in this article. At the same time, the design of the experiment clearly informed consumers of the presence of a carbon tax, both explaining its presence before consumers entered the store, and announcing the amount next to the price of each product in store. Consumers may have used the tax as information on the environmental quality of each product, as well as on the interest of the policymaker in discouraging the consumption of certain products (McAdams 1997; Sunstein and Reisch 2014). To this extent, research has shown that taxes advertised to consumers may have an additional behavioural effect beyond the pure price effect (see Zizzo et al. 2016). Nevertheless, given the absence of the carbon tax in the actual marketplace, the direct reference to a carbon tax was used to ensure participants could access information on the tax relatively easily during a time-consuming task like shopping in a new and unfamiliar supermarket.

The strong response observed in the results is an indication that consumers are very sensitive to food price increases. In fact, results suggest that consumers found adjustments in this sector relatively simple to obtain, responding significantly to the change in prices. However, consumers might be more price sensitive in a laboratory experiment, particularly when the can substitute behaviour in a taxed environment with unobserved behaviour without taxes outside of the laboratory: consumers might refuse to buy a product more easily, knowing they can source it later in a different store. This difference in price sensitivity is an empirical

research question that should be tested in future research to validate the results from experimental research. Finally, while this study did not formally assess the acceptance of the carbon tax in the marketplace, results clearly indicate that a carbon tax can be a viable and effective tool for or reducing food-related carbon emissions.

5.3. The quest for consistency in the construction of sustainable food baskets

As phenomena like moral licensing gained increasing attention lately in academic and policy arenas, a key policy question is how consumers can be motivated to construct sustainable food baskets consistently over time (Joosten et al. 2014; Mullen and Monin 2016). Results in this article indicate that policy can motivate consistency in sustainable online food shopping: conventional policy tools like carbon taxes motivated consumers to reduce their carbon footprint, with sizeable reductions purely driven by the change in relative prices, and without altering the psychological mind-set of consumers. Conceivably, other price-based interventions from marketing (discounts) or public policy (subsidies) can lead to similar effects and facilitate the transition to low-carbon food shopping. Apart from conventional policy instruments, behavioural interventions can also reduce the carbon footprint of the consumer (McAdams 1997; Sunstein and Reisch 2014). Results in this article indicate that nudges (such as just encouraging people to think of their recent environmental behaviour) can reduce the footprint of the basket by altering the psychological incentives and disincentives that motivate consumers. These effects remain when the nudge is presented in combination with a traditional policy instrument that modifies prices. The interaction between nudges and traditional policy instruments is currently understudied (Sunstein and Reisch 2014), and could be developed to design effective social marketing campaigns, particularly targeting consumers with different levels of environmental engagement in a different manner.

As with most behavioural and experimental literature, it remains unclear whether the effect of these interventions wears out over time. In fact, depending on the intervention being considered, the policymaker might either maintain the policy mechanism (as commonly done for taxes) or remove it (as is the case of exogenous shocks or experimental research in a lab). The addition of a long-term perspective raises questions on the long term effectiveness of a policy instrument (see e.g. Dolan, Galizzi, and Navarro-Martinez 2015). For instance, consumers might become used to the price increase caused by the carbon tax, adapting to the new set of prices over time. At the same time, a dynamic tax that is periodically updated to represent the price of carbon over time could prevent this behavioural adaptation. A study of

the long term impact of a policy would require the observation of a panel of consumers over a number of time periods in a controlled environment or in existing commercial panels, with periodically changing regulatory set-up. Further research could explore this dynamics.

6. CONCLUSIONS

This article tested for the presence for the role of environmental recall and carbon taxation on the sustainability of food shopping using incentive-compatible experimental data. Using an online supermarket, the experiment showed that a carbon tax has a strong impact on the carbon footprint of the basket. When controlling for individual heterogeneity, we also find evidence that the act of recalling past behaviour also motivated the formation of low-carbon baskets. Our research indicates policy directions that could be explored to reduce consumers' carbon footprint.

FIGURES

Figure 1: Screenshot of the online retailer

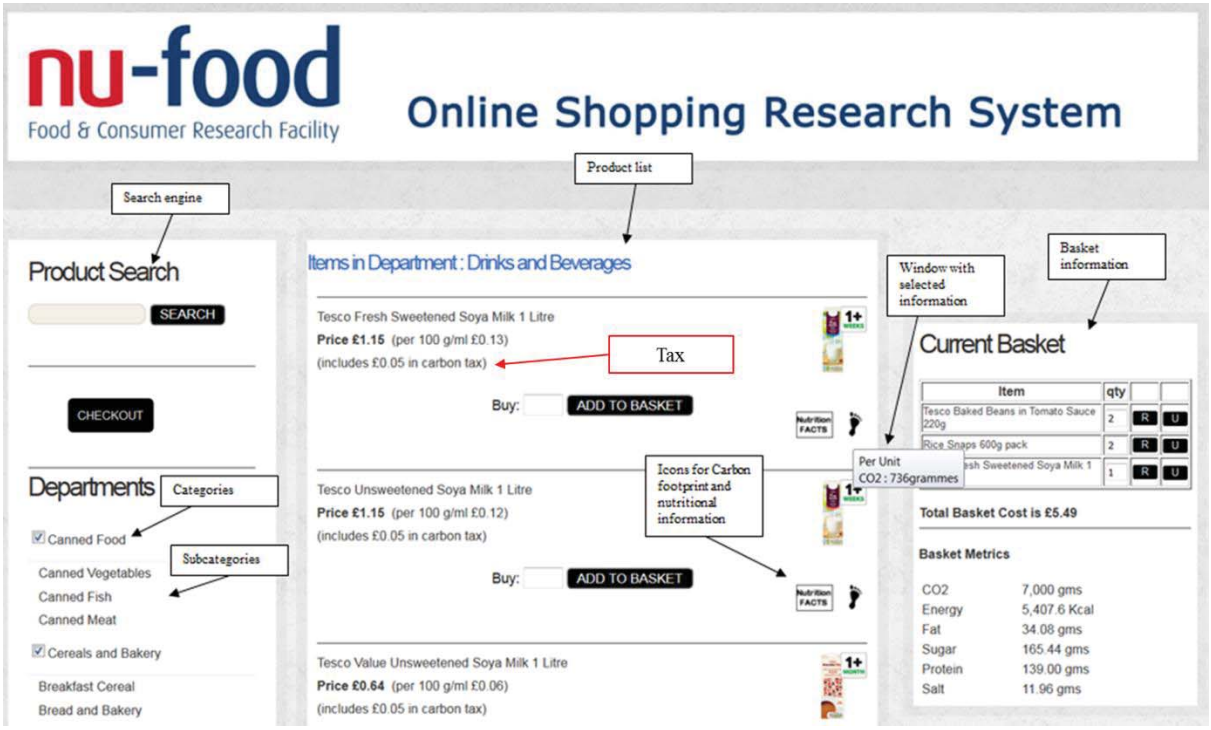


Figure 2: Diagrammatic representation of the experiment

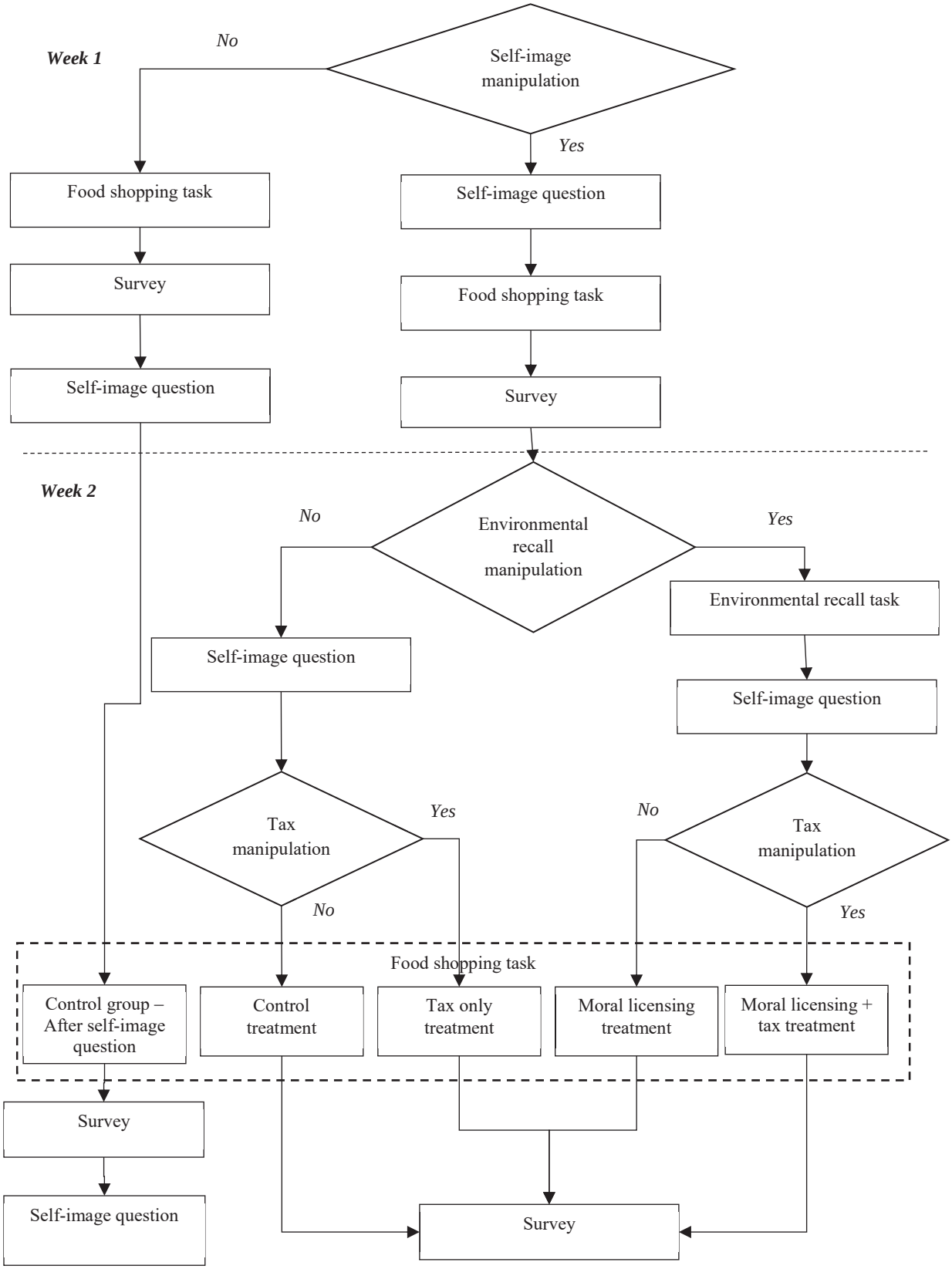
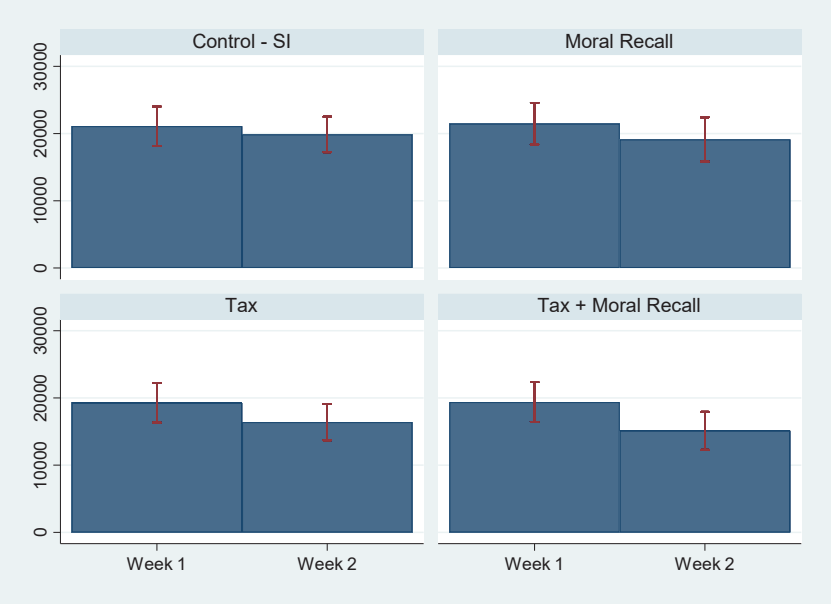
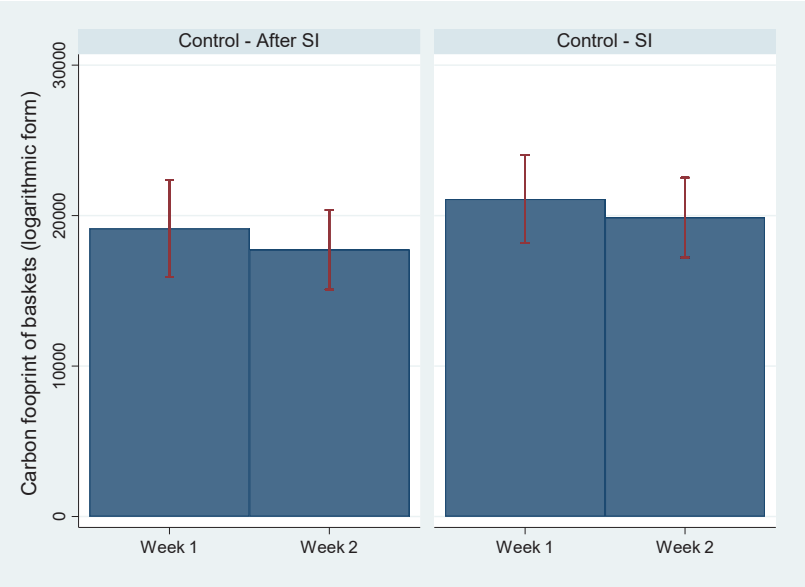


Figure 3: Changes in average basket carbon footprint across time period, by treatment



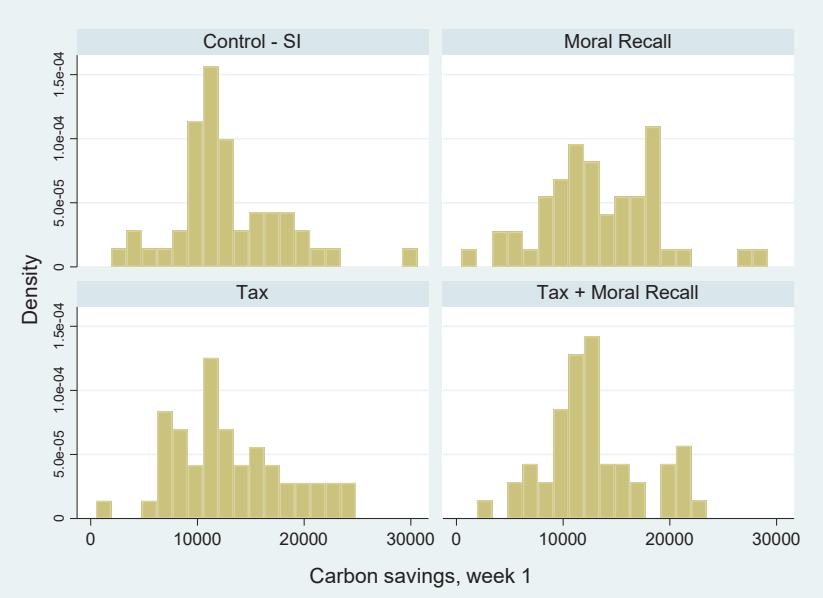
Note: Two-sample Kolmogorov-Smirnov test for equality of distribution functions – Control: D = 0.1348 (corrected p = 0.803); Environmental recall: D = 0.2157 (corrected p = 0.136); Environmental recall + Tax: D = 0.2245 (corrected p = 0.122); Tax Only: D = 0.1800 (corrected p = 0.316).

Figure 4: Changes in average basket carbon footprint across time period, by presence vs absence of a self-image question before the shopping task



Note: Two-sample Kolmogorov-Smirnov test for equality of distribution – Control with self-image question: D = 0.125 (corrected p = 0.803); Control with the after self-image question: D = 0.161 (corrected p = 0.815).

Figure 5: Distribution of estimated carbon savings by treatment

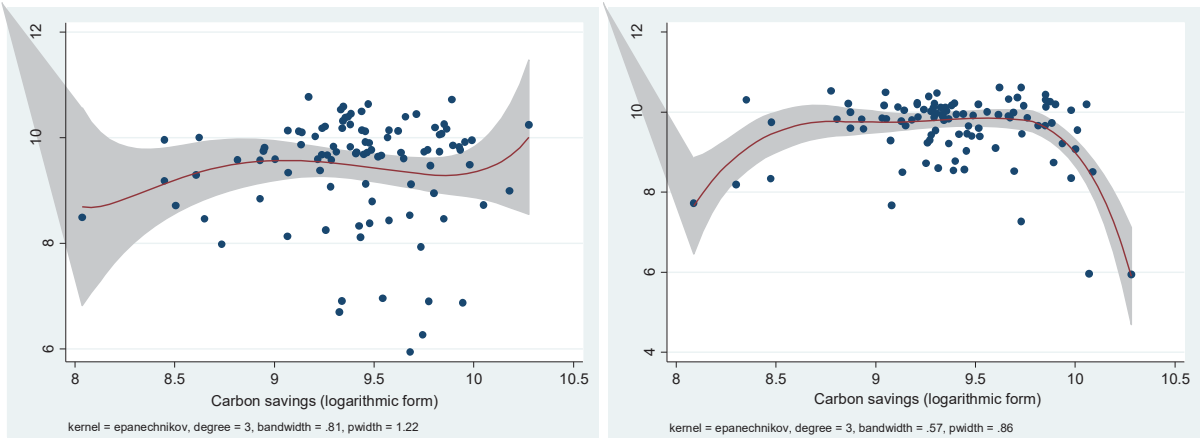


Note: A two-sample Kolmogorov-Smirnov test indicates that, relative to the control treatment, treatments do not have significantly different distributions: tax treatment (D = 0.1376, p-value = 0.665); environmental recall treatment (D = 0.1581, p-value = 0.48); environmental recall + tax treatment (D = 0.0816, p-value = 0.99). Median carbon savings did not differ across these treatments (median test, $\chi^2(3) = 2.3697$, p = 0.50).

Figure 6: Relation between estimated carbon savings and carbon footprint in the basket

a) Environmental recall before shopping

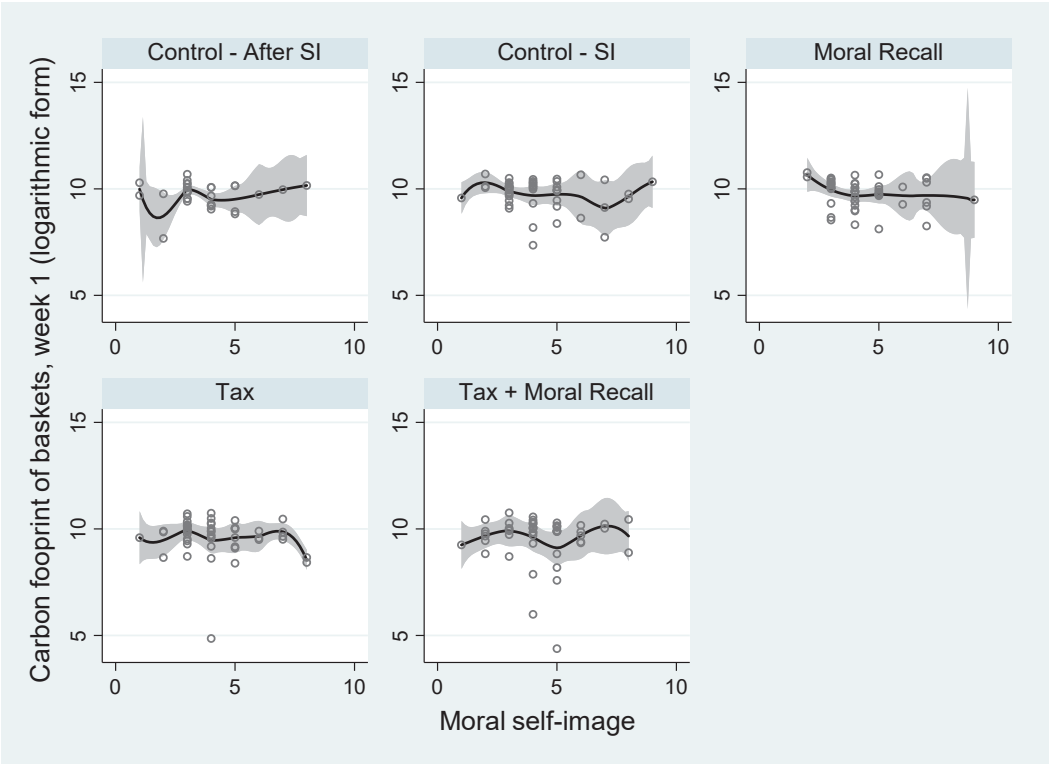
b) Environmental recall after shopping



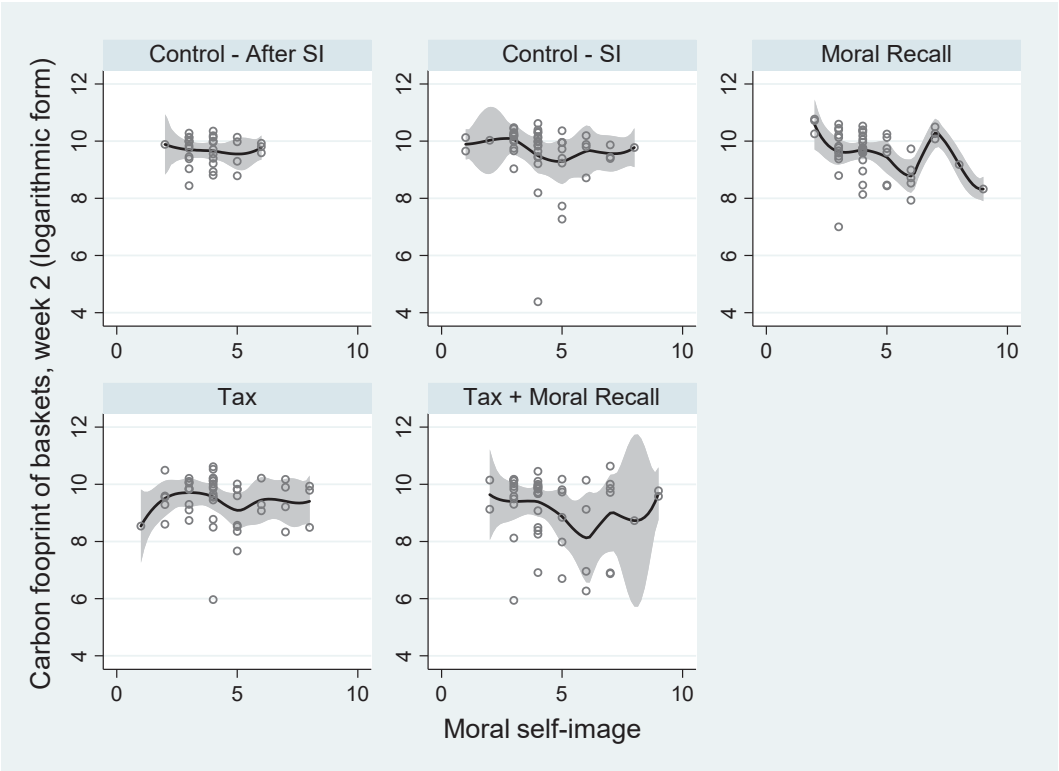
Note: Graphs based on a local polynomial regression estimation with degree 3 and Epanechnikov kernel. Graphs exclude one observation in each graph with ln(Carbon savings)<7, to retain visual clarity in the output.

Figure 7: Relation between environmental self-image (x-axis) and carbon footprint in the basket (y-axis), by week and treatment

a) Week 1



b) Week 2



Note: graphs refer to a degree 3 local polynomial regression with Gaussian kernel. Number of observations for each treatment can be found in Table 2.

TABLES

Table 1: List of environmental activities measured in the moral licensing task

Act/Frequency	g CO_2e	Units
Eaten a standard 10g portion of margarine rather than the same amount of butter	81	10 g
Used my own bag for shopping instead of using a plastic bag supplied by the retailer	10	Bag
Eaten 100g of meat substitutes rather than 100g of beef ***100g of meat equalso: a 5oz rump steak; just over a portion of Sunday roast (three thin-cut slices of roast = 90g); or a bit more than one quarter-pounder beefburger (= 78g).***	215.7	100 g
Took a shorter (2-minute) shower than the UK average (8-minute)	540	Shower
Walked rather than driven to go to University	106	Km
Cycled rather than driven to go to University	106	Km
Walked rather than took public transport to go to University	93.3	Km
Cycled rather than took public transport to go to University	-86.7[19]	Km
Washed clothing at 30 degrees rather than 60 degrees	360	Wash
Turned off your laptop completely rather than leaving it on standby	4.4	Day
Turned off your TV completely rather than leaving it on standby	4.4	Day
Turned off the tap when brushing teeth	13.5	Times
Did not waste any of the food on my plate when eating in a meal.	480	Plate
Recycled one plastic bottles	44.5	Bottle
Recycled one aluminium can	70	Can
Put an old newspaper in the recycling bin instead of the garbage bin	225	Newspaper
Put an old magazine in the recycling bin instead of the garbage bin	600	Magazine
Recycled the equivalent of one 750-ml glass bottle (typical size of a wine bottle)	73.9	750 ml bottle
Recycled the equivalent of one 500-ml glass bottle (typical size of a one-pint beer or milk bottle)	112	500 ml bottle
Recycled the equivalent of one 330-ml glass bottle (typical size of a small beer bottle)	168	330 ml bottle
I turned off unnecessary lights in my home (enter number of days)	665.7	Day

[19] This value adds the carbon emissions associated to a shower straight after cycling.

Table 2: Summary demographics of the sample by treatment

	Control – After self-image question	Control – Self-image	Moral recall	Tax	Moral Recall x Tax	χ^2
Male	0.23	0.31	0.37	0.34	0.41	3.296
S. D.	0.43	0.47	0.49	0.48	0.50	
Age	24.89	23.38	24.40	24.80	23.36	1.777
S. D.	9.88	4.64	6.73	5.91	4.18	
British	0.55	0.49	0.67	0.46	0.33	9.094*
S. D.	0.51	0.51	0.48	0.50	0.47	
Member of Environmental Association	0.06	0.08	0.10	0.10	0.06	0.179
S. D.	0.25	0.28	0.30	0.30	0.24	
CO_2e Savings (g) (week 2)	13,133	12,774	13,386	13,004	12,898	0.776
S. D.	4,844	4,992	5,430	5,310	4,663	
Observations	31	49	51	50	49	

Significance is as follows: * = 10%; ** = 5%; *** = 1%. Note: Chi^2 refers to the critical value of a Kruskal-Wallis Test comparing demographics across group.

Table 3: Summary basket statistics per treatment and week

		Week	Control – After self-image question	Control – Self-image	Moral recall	Tax	Environmental recall +Tax	χ^2
Expenditures (£)	Mean	1	19.18	17.73	17.63	17.47	17.02	1.422
	S. D.		5.90	7.29	6.81	7.12	7.33	
	Mean	2	18.25	16.58	16.48	16.59	15.33	2.262
	S. D.		6.31	7.45	7.47	8.06	8.31	
	Diff.		-0.93	-1.15	-1.15	-0.88	-1.69	0.277
CO_2 footprint (gCO_2e)	Mean	1	19,142	21,381	21,494	19,258	19,347	2.492
	S. D.		8,808	1,491	1,548	1,461	1,471	
	Mean	2	17,722	19,878	19,118	16,404	15,120	7.142
	S. D.		7,208	1,319	1,634	1,346	1,406	
	Diff.		-1,404	-1,503	-2,376**	-2,854	-4,227*	8.784*
Moral Self-Image	Mean	1	3.68	4.18	4.33	4.18	4.29	4.576
	S. D.		1.51	1.69	1.51	1.59	1.57	
	Mean	2	3.87	4.18	4.29	4.30	4.61	2.994
	S. D.		1.02	1.45	1.51	1.68	1.73	
	Diff.		0.19	0	-0.04	0.12	0.32	3.582
Observations			31	49	51	50	49	

Note: A significant estimate in week 2 refer to a Median test of the difference between the median of the distributions in Week 2 and Week 1. χ^2 refers to the critical value of a Kruskal-Wallis Test comparing behaviour and self-image across the five groups. Significance is as follows: * = 10%; ** = 5%; *** = 1%.

Table 4: Spearman correlations between environmental self-image and related variables.

Week	Variable	Control – After Soc. Image	Control – Social Image	Recall	Tax	Tax + Recall	All Sample
1	**Self-perception 1**	0.341	0.582***	0.462***	0.362	0.463***	0.444***
	Self-perception 2	0.149	0.446**	0.237	0.231	0.394*	0.294***
	Moral Obligation	0.060	0.184	0.138	0.083	0.220	0.131
	Identity – Symbolisation	0.239	0.633***	0.276	0.318	0.374	0.367***
	Identity – Internalisation	-0.096	0.060	0.050	0.201	0.158	0.078
	CO_2e consumed	-0.110	-0.106	-0.283	-0.182	0.010	-0.131
	CO_2e Saved	0.160	-0.008	0.048	0.029	0.015	0.032
2	**Self-perception 1**	0.289	0.480***	0.283	0.203	0.199	0.284***
	Self-perception 2	0.103	0.490***	0.144	0.373	0.414**	0.307***
	Moral Obligation	0.028	0.183	-0.087	-0.004	0.110	0.050
	Identity – Symbolisation	0.563**	0.498***	0.421**	0.245	0.424**	0.412***
	Identity – Internalisation	0.251	0.006	0.068	0.169	0.000	0.055
	CO_2e consumed	-0.098	-0.385**	-0.305*	-0.115	-0.204	-0.221***
	CO_2e Saved	0.327	-0.162	0.187	0.071	0.174	0.087

Note: significance is based on p-values after a Bonferroni adjustment, regressing multiple correlations of carbon variables and psychometric variables separately for consistency in the adjustment. Variables refer to the answer/agreement to the following statements: Self-perception 1 – I think my behaviour is environmentally responsible (1=totally don't agree, 7=totally agree); Self-perception 2 – When I buy a product, I take environmental considerations into account (1=totally don't agree, 7=totally agree); Moral obligation scale – I feel morally obliged to protect the environment (1=totally don't agree, 7=totally agree).

Table 5: Regression estimates of the impact of treatments on the CO_2e of the basket (week 2)

Model	**A**	**B**	**C**	**D**	**E**
	Main effects & interaction	A + Past Consumption	B + demographics	C + Attitudes	D + Expenditures
Intercept†	9.7649***	9.4729	-0.3901	-1.8110	4.9319***
S.E.	0.0965	0.2918	8.2472	7.8810	1.8295
Environmental recall	-0.1556	-0.1370	-0.1709*	-0.1842**	-0.1575**
S.E.	0.1487	0.0940	0.0876	0.0918	0.0717
Tax	-0.3051**	-0.1534**	-0.1561**	-0.1111	-0.1178*
S.E.	0.1537	0.0691	0.0725	0.0794	0.0604
Environmental recall x Tax	-0.1179	-0.0685	0.0010	-0.0098	-0.0198
S.E.	0.2576	0.1619	0.1565	0.1623	0.1012
$\ln(CO_2)_{t-1}$	-	0.8247***	0.8101***	0.7869***	0.5452***
S.E.		0.0576	0.0560	0.0651	0.1272
Male†	-	-	-0.6642	-0.6080	-0.0391**
S.E.			0.5047	0.4549	0.1761
Age†	-	-	0.0342	0.0329	0.0059
S.E.			0.0359	0.0336	0.0116
British†	-	-	0.9515	0.5621	0.0733
S.E.			0.4658	0.4788	0.1416
$\ln(CO_2e$ saved) †	-	-	0.9430	1.0105	0.2068
S.E.			0.8905	0.7618	0.1789
Identity – Symbolisation	-	-	-	0.0543	0.0091
S.E.				0.0943	0.0566
Identity – Internalisation	-	-	-	0.0641	-0.0305
S.E.				0.0768	0.0456
Social Desirability Scale	-	-	-	-0.0200	-0.0141
S.E.				0.0223	0.0132
CO_2 footprint knowledge	-	-	-	0.0304	0.0187
S.E.				0.0313	0.0249
Discount rate	-	-	-	0.1806	-0.0505
S.E.				0.3035	0.1708
Self-perception 1	-	-	-	0.0260	0.0442
S.E.				0.0509	0.0361
Self-perception 2	-	-	-	-0.0229	0.0386
S.E.				0.0426	0.0303
Ln(expenditures)	-	-	-	-	0.9455***
S.E.					-0.1265
Observations	198	198	198	198	198
R^2	0.0530	0.6260	0.6490	0.668	0.862
Adjusted R^2	0.0380	0.6180	0.6340	0.626	0.842

Marginal effects:					
Environmental recall	-2,757.67	-2428.76	-3028.82	-3264.33	-2792.66
S.E.	1,584.64	1395.64	1740.45	1875.79	1604.75
Tax	-5,408.39	-2719.02	-2767.02	-1969.11	-2088.35
S.E.	3,107.83	1562.43	1590.02	1131.51	1200.03
Environmental recall x Tax	-2,089.53	-1213.46	17.40	-173.32	-350.60
S.E.	1,200.71	697.29	10.00	99.60	201.47

Significance is as follows: * = 10%; ** = 5%; *** = 1%. S.E. refers to robust standard. For variables identified with †, the value in the table refers to the estimated coefficient divided by (1-ρ), as from equation (17), and the relative standard errors have been estimated using the Delta method. Self-perception variables refer to the agreement to the following statements: Self-perception 1 – I think my behaviour is environmentally responsible (1=totally don't agree, 7=totally agree); Self-perception 2 – When I buy a product, I take environmental considerations into account (1=totally don't agree, 7=totally agree).

Table 6: Regression estimates of the impact of treatments on the CO_2/£ of the basket (week 2)

Model	**A**	**B**	**C**	**D**	**E**
	Main effects & interaction	A + Past consumption	B + demographics	C + Attitudes	D + Expenditures
Intercept†	7.0802***	7.1088***	5.4206***	5.0781***	4.9237***
S.E.	0.0450	0.0780	1.4749	1.6794	1.8200
Environmental recall	-0.1196	-0.1158*	-0.1185*	-0.1566**	-0.1588**
S.E.	0.0763	0.0653	0.0641	0.0711	0.0718
Tax	-0.2060***	-0.1362**	-0.1284**	-0.1184*	-0.1183*
S.E.	0.0647	0.0557	0.0563	0.0605	0.0604
Environmental recall x Tax	-0.0102	-0.0561	-0.0382	-0.0209	-0.0199
S.E.	0.1213	0.1043	0.0978	0.0999	0.1013
$\ln(CO_2)_{t-1}$	-	0.5014***	0.5283***	0.5281***	0.5404***
S.E.		0.1601	0.1549	0.1501	0.1282
Male†	-	-	-0.3378*	-0.3840**	-0.3875**
S.E.			0.1786	0.1774	0.1744
Age†	-	-	0.0026	0.0049	0.0059
S.E.			0.0101	0.0112	0.0115
British†	-	-	0.1157	0.0570	0.0746
S.E.			0.1171	0.1305	0.1405
$\ln(CO_2e$ saved)†	-	-	0.1794	0.1830	0.2063
S.E.			0.1599	0.1666	0.1779
Identity – Symbolisation	-	-	-	0.0071	0.0090
S.E.				0.0559	0.0568
Identity – Internalisation	-	-	-	-0.0376	-0.0316
S.E.				0.0496	0.0458
Social Desirability Scale	-	-	-	-0.0137	-0.0140
S.E.				0.0131	0.0132
CO_2footprint knowledge	-	-	-	0.0186	0.0196
S.E.				0.0247	0.0250
Discount rate	-	-	-	-0.0681	-0.0512

S.E.				0.1649	0.1713
Self-perception 1	-	-	-	0.0457	0.0440
S.E.				0.0359	0.0362
Self-perception 2	-	-	-	0.0422	0.0387
S.E.				0.0306	0.0304
Ln(expenditures)	-	-	-	-	-0.0616
S.E.					-0.1272
Observations	198	198	198	198	198
R^2	0.0760	0.2760	0.3180	0.385	0.389
Adjusted R^2	0.0620	0.2610	0.2890	0.308	0.304
Marginal effects:					
Environmental recall	-2,120.63	-2052.71	-2100.58	-2775.24	-2815.39
S.E.	1,218.58	1179.55	1207.06	1594.74	1617.81
Tax	-3,651.35	-2414.32	-2276.39	-2097.95	-2096.38
S.E.	2,098.18	1387.34	1308.08	1205.55	1204.64
Environmental recall x Tax	-180.51	-993.58	-676.74	-370.30	-353.17
S.E.	103.73	570.94	388.88	212.79	202.94

Significance is as follows: * = 10%; ** = 5%; *** = 1%. S.E. refers to robust standard. For variables identified with †, the value in the table refers to the estimated coefficient divided by $(1-\rho)$, as from equation (17), and the relative standard errors have been estimated using the Delta method. Self-perception variables refer to the agreement to the following statements: Self-perception 1 – I think my behaviour is environmentally responsible (1=totally don't agree, 7=totally agree); Self-perception 2 – When I buy a product, I take environmental considerations into account (1=totally don't agree, 7=totally agree).

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THE IMPACT OF ENVIRONMENTAL RECALL AND CARBON TAXATION ON THE CARBON FOOTPRINT OF SUPERMARKET SHOPPING

ONLINE APPENDICES

APPENDIX 1. EXPERIMENTAL INSTRUCTIONS

Thank you for your participation to this research. With your answers we are trying to understand what drives consumer choices, and how these factors determine what consumers buy during a grocery shopping trip. All the information you give us will be completely confidential: we will give you an anonymous ID code, and no one (including the investigator) will know the information in the data belongs to you. The data will be subject to statistical analysis and will be stored indefinitely in a safe repository inaccessible to anyone outside the research team.

In this research, you will be assigned a virtual weekly budget of £20 to spend on grocery shopping online. You can spend as much of this in our virtual shop as you wish. It is important that you make choices as you would in any shopping trip you make. At the end of each week, we will select randomly 1 participant to the experiment in every 5, i.e. 20% of participants. These selected participants will actually receive the goods they ordered in their online shopping trip and receive in cash the balance of the £20 not spent in the chosen week. Please notice that while we source our products from Tesco stores for convenience, Tesco has no involvement in this research.

In addition, every participant will receive £5 as recognition of the time spent in taking part in this research. This money, which is guaranteed to you, is independent on what you purchase or the answers you give. **You will receive the £5 at the end of the second week**.

After completion of the experiment, you will also be able to withdraw within six weeks of your last visit by contacting Dr Luca Panzone, School of Agricultural, Food and Rural Development, Newcastle University, phone: 0191 2083594, e-mail: l.a.panzone@newcastle.ac.uk and quoting your ID code.

CONSENT FORM

Please tick all in order to proceed. You can ask for details of points you do not wish to tick to the Research Assistant.

I have read and understood the information in the Information Sheet.	o
I have been given the opportunity to ask questions about the project and my participation.	o
I understand that in compensation for my time I will receive £5 for 2 weeks of survey. I will receive this money at the end of the second survey.	o
I understand that I will be given a notional £25 budget each week and asked to make purchases in the online shop; I can spend as much or as little as I choose provided it is within the £25 budget.	o
I understand that I will receive one of my two chosen basket of goods and the money I have not spent in the same week, in which case I will accept the items I purchased.	o
I understand that all the anonymised information deriving from the experiments will be completely confidential and the data will be stored indefinitely in a safe repository of Newcastle University.	o
I understand that I can withdraw at any point during this research, including after completion by contacting Luca Panzone within 6 weeks of my last visit.	o
I understand that the anonymised data will be used for publication of the outcomes of this research, and I agree that the data can be used in this way.	○

We take your decision to answer the questions to be an acknowledgement that you have had the terms of your participation adequately explained and that you give your consent. For further information, you are welcome to contact Dr Luca Panzone at any time using the contact details indicated above.

I accept the terms and conditions (Yes/No)

Environmental recall questionnaire (when applicable)

Please pause one moment and think about the activities you have done in the past week (i.e. the past 7 days) to help protect the natural environment for you and for others. How often have you done any of these during the last week? (randomised order)

Act/Frequency	**Please specify the number of occasions:**	**Never**
Eaten a standard 10g portion of margarine rather than the same amount of butter	_____times	o
Used my own bag for shopping instead of using a plastic bag supplied by the retailer when shopping	_____times	o
Did not waste any of the food on my plate when eating in a meal.	_____times	o
Eaten 100g of meat substitutes rather than 100g of beef ***100g of meat equals to:*** *a 5oz rump steak; just over a portion of Sunday roast (three thin-cut slices of roast = 90g); or a bit more than one quarter-pounder beefburger (= 78g).*	_____times	o
Took a shorter (2-minute) shower than the UK average (8-minute)	_____times	o
Walked rather than driven to go to University	_____times	o
Cycled rather than driven to go to University	_____times	o
Walked rather than took public transport to go to University	_____times	o
Cycled rather than took public transport to go to University	_____times	o
Washed clothing at 30 degrees rather than 60 degrees	_____times	o
Turned off your laptop completely rather than leaving it on standby	_____times	o
Turned off your TV completely rather than leaving it on standby	_____times	o
Turned off the tap when brushing teeth	_____times	o
Recycled one aluminium can	_____times	o
Put an old newspaper in the recycling bin instead of the garbage bin	_____times	o
Put an old magazine in the recycling bin instead of the garbage bin	_____times	o
Recycled the equivalent of one 750-ml glass bottle (this is the typical size of a wine bottle)	_____times	o

Recycled the equivalent of one 500-ml glass bottle (this is the typical size of a one-pint beer or milk bottle)	_____times	o
Recycled the equivalent of one 330-ml glass bottle (this is the typical size of a small beer bottle)	_____times	o
Recycled one plastic bottles	_____times	o
I turned off unnecessary lights in my home (enter number of days)	_____times	o

Please indicate the distance between your house and the University: _____

If over the past week you have done any other actions not in the table above that involved effort and time to help protect the environment, please use the box below to give a short description of these actions, indicating the amount of time (in minutes) you dedicated to them.

Over the past week by carrying out these acts you have saved [VALUE TO BE DISPLAYED] grams of carbon footprint.

Moral self-image scale (Jordan, Leliveld, and Tenbrunsel, 2011)

Compared to the environmentally-friendly person I want to be, I am:

1	2	3	4	5	6	7	8	9
Much less environmentally friendly than the person I want to be				*Exactly as environmentally friendly as the person I want to be*				*Much more environmentally friendly than the person I want to be*

SUPERMARKET SHOPPING

CHECK OUT OF SHOPPING TRIP

Inventory:

How much of the following food do you currently have in your home?

	I never buy this product	I am currently running low	I currently I have enough
Pulses	o	o	o
Bottled Water, Fruit Juice, and Soft Drinks	o	o	o
Oil, margarine, and butter	o	o	o
Cheese, milk, and other dairy products	o	o	o
Fish	o	o	o
Bread and bakery products	o	o	o
Meat	o	o	o
Vegetables (fresh, frozen, and canned)	o	o	o
Fruit	o	o	o
Rice and Pasta	o	o	o
Breakfast Cereal	o	o	o
Eggs	o	o	o
Non-Dairy Milk	o	o	o
Salt, Sugar	o	o	o
Tea, Coffee	o	o	o
Sauces (e.g. mustard, ketchup)	o	o	o
Honey and Jam	o	o	o
Flour	o	o	o

Willingness to Pay Question

Suppose you consume 1000 KWh or electricity bill a year. This amount of energy costs you £ 120/year, and generates 500kg of carbon emissions. You receive a leaflet from another electricity supplier of comparable quality who can give you the same electricity, but generated from more renewable sources than your current supplier. Changing to this new supplier would reduce the carbon generated by your 1000 KWh electricity consumption by 20%; so by switching you would save 100kg of carbon without reducing your electricity use.

However, this change will increase the cost of your initial bill. How much more would you be willing to pay on top of the £120 a year you currently pay for electricity to reduce the carbon footprint of your electricity consumption by 100kg?

£ _____

Self-control (Zauberman et al. 2009)

Imagine receiving a gift certificate worth £50, valid from today. How much would you need to be paid to wait before using the gift certificate for:

- 1 year: _____

Pro-environmental Attitudes (Cornelissen et al. 2008) (1=very negative, 7=very positive)

- How do you feel about environmental behaviours?
- How do you feel about performing environmental behaviours?
- How important is it that you perform environmental behaviours?

Self-perception scale (Cornelissen et al. 2008) (1=totally don't agree, 7=totally agree)

- I think my behaviour is environmentally responsible
- When I buy a product, I take environmental considerations into account.

Moral obligation scale (Cornelissen et al. 2008) (1=totally don't agree, 7=totally agree)

- I feel morally obliged to protect the environment

Moral identity (Aquino and Reed, 2002) (1=totally don't agree, 7=totally agree)

1. Caring for the environment is an important part of who I am.
2. I often buy products that communicate the fact that I care for the environment
3. The types of things I do in my spare time (e.g., hobbies) clearly identify me as caring for the environment.
4. The kinds of books and magazines that I read identify me as caring for the environment.
5. I am actively involved in activities that communicate to others that I care for the environment.
6. It would make me feel good to be a person who cares for the environment.
7. A big part of my emotional well-being is tied up in caring for the environment.
8. I would be ashamed to be a person who cares for the environment. (R)
9. Caring for the environment is not really important to me. (R)
10. Caring for the environment is an important part of my sense of self.
11. I strongly desire to care for the environment.
12. I often wear clothes that identify me as caring for the environment.
13. The fact that I care for the environment is communicated to others by my membership in certain organizations.

Social Desirability Scale (short version) (Stöber 2001)

Please read each statement carefully and decide if that statement describes you or not. If it describes you, check the word "true"; if not, check the word "false".

	True	False
I sometimes litter.	o	o

I always admit my mistakes openly and face the potential negative consequences.	o	o
In traffic I am always polite and considerate of others.	o	o
I have tried illegal drugs (for example, marijuana, cocaine, etc.).	o	o
I always accept others' opinions, even when they don't agree with my own.	o	o
I take out my bad moods on others now and then.	o	o
There has been an occasion when I took advantage of someone else.	o	o
In conversations I always listen attentively and let others finish their sentences.	o	o
I never hesitate to help someone in case of emergency.	o	o
When I have made a promise, I keep it--no ifs, ands or buts.	o	o
I occasionally speak badly of others behind their back.	o	o
I would never live off other people.	o	o
I always stay friendly and courteous with other people, even when I am stressed out.	o	o
During arguments I always stay objective and matter-of-fact.	o	o
There has been at least one occasion when I failed to return an item that I borrowed.	o	o
I always eat a healthy diet.	o	o
Sometimes I only help because I expect something in return.	o	o

Environmental Literacy *(objectives: 1) to test if people pay more attention to footprint; 2) to test if people have prior knowledge of carbon footprint)*

- Which of these products do you think is **higher** in carbon footprint? (also in store)

  (2 litres of Cola in 1 plastic bottle; 2 litres of Cola in six 330-ml cans; Both the same; Not sure/Don't know).

- Which of these products do you think is **higher** in carbon footprint? (also in store)

  (A pack of 6 own-labelled organic eggs; a pack of 6 own-labelled free-range eggs; Both the same; Not sure/Don't know).

- Which of these products do you think is **higher** in carbon footprint? (also in store)

  (A pint of whole milk; A pint of skimmed milk; both the same; Not sure/Don't know)

- Which of these products do you think is **higher** in carbon footprint? (also in store)

(1 litre of Orange Juice not-from-concentrate; 1 litre of Orange Juice from-concentrate; both the same; Not sure/Don't know)

- Which of these products do you think is **higher** in carbon footprint? (not in store)

  (A 500g portion of Chicken Biryani; A 500g portion of Shepherd's Pie; both the same; Not sure/Don't know)

- Which of these products do you think is **higher** in carbon footprint? (not in store)

  (One Thin Crust Cheese Feast Pizza; One Thin Crust Pepperoni Pizza; Both the same; Not sure/Don't know)

- Which of these products do you think is **higher** in carbon footprint? (not in store)

  (1 litre of lager beer in two 500ml cans; 1 litre of lager beer in four 250ml bottles; both the same; Not sure/Don't know)

- Which of these products do you think is **higher** in carbon footprint? (not in store)

  (A standard 250-ml cup of latte; A standard 250-ml cup of cappuccino; Both the same; Not sure/Don't know)

You are:

☐ Male ☐ Female

Your age group:

☐ 18-25

☐ 26-35

☐ 36-45

☐ 46-55

☐ More than 55

Your nationality: _____

Year of Study

☐ Year 1

☐ Year 2

☐ Year 3

☐ Master course

☐ PhD

Faculty of Study

☐ Science, Agriculture, and Engineering

☐ Humanities and Social Science

☐ Medical Science

How would you describe your ethnicity?

☐ White

☐ Mixed

☐ Asian or Asian British

☐ Black or Black British

☐ Chinese or other ethnic group

☐ Others – please specify: _____

What is your religion?

☐ Christian

☐ Jewish

☐ Muslim

☐ Hindu

☐ Buddhist

☐ None (atheist or agnostic)

☐ Others – please specify: _____

What political party do you support or identify with?

☐ Conservative Party

☐ Labour Party

☐ Green Party

☐ Liberal Democrats

☐ Others – please specify: _____

Membership of an environmental association

Are you a member of an environmental association (e.g. Friends of the Earth, WWF)? If yes, please specify: _____

APPENDIX 1. ADDITIONAL INFORMATION ON PSYCHOLOGICAL SCALES

1) ENVIRONMENTAL IDENTITY SCALE

To estimate the moral identity scale, the approach follows (Aquino and Reed 2002). Specifically, participants had to identify their agreement with a list of statement associated to being "environmentally-friendly" as the only personal characteristic. Answers were then analysed using a principal component analysis (PCA) with Varimax rotation after recoding the two negative statements ("I would be ashamed to be a person who has these characteristics" and "Having these characteristics is not really important to me"). Results are reported in table A1 below, and mirror the results presented in Aquino and Reed (2002). In particular, the PCA obtains 2 factors: a first factor consists of six items that measure the **internalisation** of pro-environmental identity, the extent by which this identity is central to the self-concept of the respondent; while a second factor of seven items measures the **symbolisation** of pro-environmental identity, which measures the degree to which the respondent feels this identity is reflected in his actions and behaviours. The variables used in the final regression refer to the estimated Bartlett score from the PCA.

Table A1: Rotated factor loadings from the PCA

		Week 2		Week 1	
		Symbolisation	**Internalisation**	**Symbolisation**	**Internalisation**
1	Caring for the environment is an important part of who I am.	0.4858	**0.7078**	0.5525	**0.6126**
2	I often buy products that communicate the fact that I care for the environment	**0.6320**	0.4718	**0.5535**	0.4099
3	The types of things I do in my spare time (e.g., hobbies) clearly identify me as caring for the environment.	**0.8161**	0.3108	**0.7816**	0.2082
4	The kinds of books and magazines that I read identify me as caring for the environment.	**0.8255**	0.2468	**0.7133**	0.2964
5	I am actively involved in activities that communicate to others that I care for the environment.	**0.8615**	0.1869	**0.8333**	0.2157

6	It would make me feel good to be a person who cares for the environment.	0.1062	**0.7824**	0.2471	**0.6778**
7	A big part of my emotional well-being is tied up in caring for the environment.	**0.6573**	0.5562	**0.7398**	0.4541
8	I would be ashamed to be a person who cares for the environment. (Reverse-coded)	-0.4474	0.4027	-0.4545	**0.5631**
9	Caring for the environment is not really important to me. (Reverse-coded)	0.0394	**0.7226**	0.1487	**0.7427**
10	Caring for the environment is an important part of my sense of self.	**0.6050**	0.5700	**0.6785**	0.5021
11	I strongly desire to care for the environment.	0.2971	**0.8226**	0.4774	**0.6073**
12	I often wear clothes that identify me as caring for the environment.	**0.8159**	0.0679	**0.7696**	0.0113
13	The fact that I care for the environment is communicated to others by my membership in certain organizations.	**0.8006**	0.1060	**0.7536**	0.0182

2) SOCIAL DESIRABILITY SCALE (SDS)

To estimate the social desirability of participants, the questionnaire used the 17-item scale developed by Stöber (2001). This approach uses 17 true/false questions to gauge the propensity of an individual to behave in a socially desirable manner. These 17 items have then been summed into a single index going from 0 to 17, after reverse-coding those with socially undesirable behaviours (highlighted in bold in table A2). Cronbach's alpha of the final variables is 0.55 in week 1, and 0.65 in week 2. On average, participants scored 10.5 in week 1, and 10.3 in week 2, with no significant difference across treatment groups (Kruskal-Wallis test: $chi^2 = 0.464$; $p = 0.9268$). The variable enters the regressions linearly.

Table A2: Elements of the SDS scale

	True	False
I sometimes litter.	o	o
I always admit my mistakes openly and face the potential negative consequences.	o	o
In traffic I am always polite and considerate of others.	o	o
I have tried illegal drugs (for example, marijuana, cocaine, etc.).	o	o
I always accept others' opinions, even when they don't agree with my own.	o	o

I take out my bad moods on others now and then.	o	o
There has been an occasion when I took advantage of someone else.	o	o
In conversations I always listen attentively and let others finish their sentences.	o	o
I never hesitate to help someone in case of emergency.	o	o
When I have made a promise, I keep it--no ifs, ands or buts.	o	o
I occasionally speak badly of others behind their back.	o	o
I would never live off other people.	o	o
I always stay friendly and courteous with other people, even when I am stressed out.	o	o
During arguments I always stay objective and matter-of-fact.	o	o
There has been at least one occasion when I failed to return an item that I borrowed.	o	o
I always eat a healthy diet.	o	o
Sometimes I only help because I expect something in return.	o	o