HHS Public Access

Author manuscript

Glob Environ Change. Author manuscript; available in PMC 2018 January 01.

Published in final edited form as:

Glob Environ Change. 2017 January ; 42: 136–147. doi:10.1016/j.gloenvcha.2016.11.005.

‘Green’ on the ground but not in the air: Pro-environmental attitudes are related to household behaviours but not discretionary air travel

Ian Alcock[a], **Mathew P. White**[a], **Tim Taylor**[a], **Deborah F. Coldwell**[b], **Matthew O. Gribble**[c], **Karl L. Evans**[b], **Adam Corner**[d], **Sotiris Vardoulakis**[a,e], and **Lora E. Fleming**[a]

[a]European Centre for Environment and Human Health, University of Exeter Medical School, Knowledge Spa, Royal Cornwall Hospital, Truro, Cornwall, TR1 3HD, UK

[b]Animal and Plant Sciences, Alfred Denny Building, University of Sheffield, Western Bank, Sheffield, S10 2TN, UK

[c]Department of Environmental Health, Emory University Rollins School of Public Health, 1518 Clifton Rd. NE, Mailstop 1518-002-2BB, Atlanta, GA 30322, United States

[d]Climate Outreach, 106-108 Cowley Road, Oxford, OX4 1JE, UK

[e]Environmental Change Department, Centre for Radiation, Chemical & Environmental Hazards, Public Health England, Harwell Campus, OX11 0RQ, UK

Abstract

The rise in greenhouse gas emissions from air travel could be reduced by individuals voluntarily abstaining from, or reducing, flights for leisure and recreational purposes. In theory, we might expect that people with pro-environmental value orientations and concerns about the risks of climate change, and those who engage in more pro-environmental household behaviours, would also be more likely to abstain from such voluntary air travel, or at least to fly less far. Analysis of two large datasets from the United Kingdom, weighted to be representative of the whole population, tested these associations. Using zero-inflated Poisson regression models, we found that, after accounting for potential confounders, there was no association between individuals' environmental attitudes, concern over climate change, or their routine pro-environmental household behaviours, and either their propensity to take non-work related flights, or the distances flown by those who do so. These findings contrasted with those for pro-environmental household behaviours, where associations with environmental attitudes and concern were observed. Our results offer little encouragement for policies aiming to reduce discretionary air travel through pro-environmental advocacy, or through ‘spill-over’ from interventions to improve environmental impacts of household routines.

Correspondence to: Ian Alcock.

Appendices A and B. Supplementary data: Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.gloenvcha.2016.11.005.

Keywords

Pro-environmental behaviour; Voluntary air travel; Discretionary air travel; Climate change concerns; Attitude-behaviour consistency; Pro-environmental spill-over

1. Introduction

Air passenger transport is a major contributor to global greenhouse gas (GHG) emissions (Gössling and Upham, 2009) and this contribution will continue to increase in absolute and proportional terms (IATA, 2014). Recent aviation sector contributions to global anthropogenic GHG emissions of around 3% must be viewed against a background of year-on-year growth in air travel, and the substantial reductions advocated by the Intergovernmental Panel on Climate Change. As the industry continues to grow, aviation may account for 15%–40% of global CO_2 emissions by 2050 (Dubois and Ceron, 2006; Gössling and Peeters, 2007). Widespread air travel in industrialised countries contributes to high per capita GHG emissions; (the OECD average in 2012was 12.47 t/capita). For example, CO_2 emissions per passenger on a return trip from Europe to Thailand ($2tCO_2$) equate to about half the global per capita annual average (Gössling and Upham, 2009). One potentially promising initiative was the inclusion of aviation in the EU's carbon trading scheme in 2012. However, the vast bulk of any mitigation resulting from this is likely to be in other included sectors due to the relative cost of reducing emissions in aviation (Van Renssen, 2012). No reductions are anticipated in passenger numbers. In the case of the UK, the government predicts passenger traffic will rise from 219 million in 2011, to 445 million by 2050, with CO_2 emissions from UK departure flights increasing from 33.3 to 47 $MtCO_2$ (Department for Transport, 2013). Despite the expectation of rising air passenger numbers, there is increasing interest in the potential for policy initiatives to promote more environmentally sustainable behaviour.

Recent UK governments have expressed a strong preference for non-regulatory policy tools with regard to behaviour change interventions, which are claimed to encourage, support and enable people to make better choices for themselves whilst respecting individual freedom (Cabinet Office, 2011). Such policies are said to contrast with legislation and taxation measures, which may be ineffective or damaging (House of Lords, 2011). Consistent with this approach, the Centre of Expertise on Influencing Behaviours within the UK government's Department for the Environment, Food and Rural Affairs produced a Framework for Sustainable Lifestyles (DEFRA, 2011) which identified “Making the most of lower-carbon alternatives to flying, for example trains” as a key behavioural target. The conflict between the immediate benefits to the individual from flying for tourism/recreation and negative consequences to the collective from climate change (Bohr, 2014) often remains unaddressed. At the European level, debate is premised on the absence of any widely communicated social norms on how much air travel is acceptable, and the related political implausibility of limiting currently available options, or even regulating to restrict the advertisement and marketing of holiday flights (Umpfenbach, 2014).

Given this policy background, it is essential to quantify the potential links and spill-overs between pro-environmental attitudes and behaviours. Air travel is generally for either work-related, or discretionary purposes (e.g., holidays, social visits), with the latter arguably more subject to individual control. Arguably, people with more pro-environmental attitudes, concern about climate change, and engagement in pro-environmental household behaviours will be more likely to also avoid or reduce discretionary flights (Kroesen, 2013). This 'pro-environmental consistency hypothesis' is the subject of the current study. There is some support from pro-environmental engagement in other contexts for the idea that different environmentally beneficial behaviours are motivated by common pro-environmental values and concern (Thøgersen and Ölander, 2006). Some studies report a positive association between pro-environmental attitudes, including concerns about climate change, and various pro-environmental behaviours (Ortega-Egea et al., 2014; Whitmarsh and O'Neill, 2010; O'Connor et al., 1999). Nevertheless, results are inconsistent and evidence of an 'attitude-behaviour gap' has also been reported (Lorenzoni et al., 2007). Furthermore, very little research has examined the relationship between routine pro-environmental behaviours in the home, the focus of government behaviour change messages in the UK (DEFRA, 2011), and discretionary air travel.

Of the few small-scale and qualitative studies that have begun to address this issue, results have been mixed. Some showed no association between pro-environmental attitudes and household behaviours, and non-work related flights (Cohen et al., 2013; Kroesen, 2013; McKercher et al., 2010; Randles and Mander, 2009), or even a negative association, with more concerned individuals flying more (Barr et al., 2011), though lower flight frequency amongst those with a more pro-environmental worldview has also been reported (Davison et al., 2014). Although suggestive, the small sample sizes and inability to control for a host of potentially relevant socio-demographic and psychological variables make interpreting these findings difficult. The present study extended this line of research by using secondary datasets from England (Climate Change and Transport Choices, CCTC, n = 3923) and the UK (British Household Panel Survey, BHPS Wave 18, n=14,419) to both make national population level estimates of relationships, and control on a wide range of potential confounders. Both datasets allowed estimation of associations between flight behaviour, and pro-environmental attitudes and concern about climate change, and the BHPS further allowed estimation of associations between flight behaviour and household behaviours. Both datasets allowed adjusted models to control for the effects of socio-demographic factors, and the BHPS further allowed control on relevant psychological factors and personality traits.

1.1. Estimating flying behaviour and pro-environmentalism

Using self-report data, the current work considered two aspects of voluntary (or non-work related) flying behaviour: a) people who abstain, compared to people who don't, and b) distances flown by those with a propensity to take discretionary flights. Given that GHG emissions are related to distance flown, we felt that it was important to explore not simply whether 'greener' citizens flew less frequently, but also whether they tended to fly less far. In terms of pro-environmentalism we considered individuals': a) general pro-environmental attitudes (e.g., how important it is to do things that are environmentally friendly); b) concern about the consequences of climate change (e.g., flooding); and c) frequency of household

related pro-environmental behaviours (e.g., avoiding products with excess packaging). Distinguishing between these three elements of pro-environmentalism is consistent with previous work. For example, perceptions of the threat that climate change poses have been shown to be positively associated with pro-environmental behavioural intentions after accounting for the effect of pro-environmental attitudes in general (O'Connor et al., 1999). If the pro-environmental consistency hypothesis is correct, those who show greater tendencies towards pro-environmental-ism on these indicators should also exhibit less discretionary flying behaviour.

Since we used secondary data in the current analysis we were unable to explore and test extant theories concerning the antecedents of pro-environmental attitudes and behaviours (e.g., the Theory of Planned Behaviour (Ajzen, 1991), Value-Belief-Norm theory (Stern, 2000), the Comprehensive Action Determination Model (Klöckner and Blöbaum, 2010), and the Stage Model of Self-regulated Behavioural Change (Bamberg, 2013a)), including those used to explore other environmentally-related travel behaviours, such as car use (e.g., Anable, 2005; Bamberg, 2013b), because data on some of the relevant variables were not collected. In consequence this work was not designed to test a theoretical model or framework as applied to flying behaviour, but rather attempted to identify variables in the datasets we used here that could act as markers or proxies for the kind of variables discussed in these theories. In many cases suitable proxies simply did not exist (e.g., personal norms or perceived behavioural control) and thus our work is unable to speak to these constructs. Nonetheless, we were able to identify variables in the datasets that were pertinent to issues such as values, personality, and constraints on behaviour (e.g., income) have been explored in previous work on pro-environmentalism, and below we provide more details about these measures as used in the current work.

1.2. The need to control for other psychological and socio-demographicvariables

In exploring relationships between flight behaviour and pro-environmentalism, it was necessary to control for a range of individual (psychological) differences and socio-demographic factors which may be related to both flight behaviour and pro-environmentalism, and thus account for any relationship between them. Specifically we included a wide range of covariate measures that have been found to be related to pro-environmental behaviours in other contexts (see, for example, reviews by Diamantopoulos et al. (2003), and Gifford and Nilsson (2014)).

For instance, the role of values in predicting pro-environmental engagement has been emphasised by the integration of Schwartz's (1994) value model into theoretical models of pro-environmental behaviours such as the Value-Belief-Norm theory (Stern, 2000), and the Comprehensive Action Determination Model (Klöckner and Blöbaum, 2010). These theories suggest general value orientation influences ecological worldview and personal norms, and that these perceived obligations or duties towards the environment in turn impact environmental behavioural intentions and behaviours (Corner et al., 2014; Dietz et al., 2005). Within Schwartz's taxonomy (1992, [Schwartz, 1994]1994), self-transcendence and self-enhancement are two opposing higher order value orientations, and evidence suggests that self-transcendent (or ‘altruistic’) values which focus concern beyond a person's

immediate social circle are stronger among people who engage in pro-environmental activities (De Groot and Steg, 2008; Steg and Vlek, 2009). In contrast, endorsement of self-enhancing values like materialism or social power tends to be associated with lower levels of engagement with pro-environmental behaviour (Evans et al., 2012), and there is evidence of greater environmental concern among individuals with ‘pro-social’ or ‘post-materialist’ rather than individualistic or competitive social value orientations (Oreg and Katz-Gerro, 2006; Joireman et al., 2001). In the current datasets we identified an item related to the ‘importance of money’, as potentially suggesting higher self-enhancement values, because it has a direct relationship to materialism (Evans et al., 2012). If our suggestion is correct we might expect to see higher discretionary flight use among those high on the ‘importance of money’ item, reflecting the underlying importance of general life values, over and above those relating specifically to the environment (i.e., our central variables of concern). Other factors of this sort that we were able to control on included ‘interest in politics’ (Torgler and Garcia-Valiñas, 2005), ‘religiosity’ (Pepper et al., 2011), and risk aversion (Paladino, 2005; Barile et al., 2015), all of which have been positively associated with pro-environmental choices and behaviours in past work. Controlling for risk aversion is particularly important in the current context because around 40% of people who fly report some degree of anxiety (Martinussen and Hunter, 2009), and it is possible that risk aversion is associated with avoidance of air travel in particular.

Recent research has also examined relationships between pro-environmental behaviour and personality, often operationalised using the five-factor (or Big Five) model (John and Srivastava, 1999). The Big Five is a standard tool which comprises five dimensions held by psychologists to be an adequate summary of personality: ‘extraversion’ (being sociable, talkative and assertive); ‘agreeableness’ (being helpful, cooperative and caring); ‘conscientiousness’ (being reliable, self-disciplined and well-organized); ‘neuroticism’ (being anxious, depressed and insecure); and ‘openness to experience’ (being imaginative, creative, curious and questioning of conventions). Results consistently find pro-environmental outcomes positively associated with openness to experience and there is also some evidence of a positive association with agreeableness and conscientiousness (Milfont and Sibley, 2012; Fraj and Martinez, 2006; Markowitz et al., 2012; Swami et al., 2011; Hirsh, 2010; Hirsh and Dolderman, 2007). There is even a long-standing interest from the airline industry in the personalities of those who do and do not choose to fly (Plog, 2001). This industry focused research suggested that flyers (rather than non-flyers) are open to new ideas; non-flyers were also found to be less confident and assertive (Plog, 2001). The work did not, however, consider how air travel behaviour related to pro-environmental attitudes and behaviours more broadly. Importantly for the current work, one of the datasets we used contained responses to the Big Five personality questionnaire so we were able to control for these five dimensions when exploring the relationships of pro-environmental attitudes and household behaviours, with discretionary flight behaviour. To the extent that personality influences both pro-environmental attitudes and flight behaviour, not controlling for these things may find an ‘illusory’ correlation between them that would simply be accounted for by this far deeper (and much less amenable to change) psychological construct.

Finally, there is also a considerable body of research which has explored socio-demographic factors and pro-environmental engagement (Milfont et al., 2015), much of which speaks to

the objective or perceived constraints on pro-environmental behaviours. For instance, income has been shown in some studies to be associated with pro-environmental behaviour (Kemmelmeier et al., 2002; Chen et al., 2011), as has household structure (Longhi, 2013), with greater pro-environmental behaviour reported by unmarried people and couples without children. In other words, the ability to engage in some pro-environmental behaviours (e.g., purchasing local organic produce in small retailers distributed over a large geographical distance) may depend on the ability to overcome financial and/or temporal constraints. In the case of discretionary flight behaviour, however, financial and other practical barriers may act to restrict the number of flights taken, rendering individuals' behaviour to be classified as 'pro-environmental' not because of their environmental beliefs and attitudes, but simply due to their circumstances. Indeed, in the case of air travel in particular, the evidence suggests that there is a significant link with income (Gallet and Doucouliagos, 2014), and that most UK discretionary flights are taken by those in higher socio-economic groups and with above average income (Cairns and Newson, 2006). Indeed, year on year increases in UK leisure flights appear to be the result of richer people flying more frequently, rather than cheaper flights making air travel accessible to more people (Cairns and Newson, 2006).

Again, controlling for factors such as income and household structure is essential if we want to understand the link between pro-environmentalism in general and flight behaviours in particular, because it statistically accounts for some of the constraints on flying behaviour that would otherwise cloud our understanding of the consistency hypothesis. Other variables of this sort that we controlled for in the models included age, gender and education, all of which have been shown to be related to pro-environmental attitudes and behaviour in the past (Gifford and Nilsson, 2014; Hunter et al., 2004; Kemmelmeier et al., 2002; Whitmarsh 2011; Whitmarsh and O'Neill, 2010). Because these and the other variables discussed above are used in the current work to control for potential confounders on the basis of past work, we do not focus on the outcomes of the relationships between these variables and flight behaviour in the main body of the paper. Rather, our focus is on the pro-environmental consistency hypothesis once these factors have been accounted for.

1.3. The current work

In sum, our research tested whether discretionary flight behaviour showed pro-environmental consistency with regard to routine household behaviours, self-rated commitment to individual mitigation efforts, and concern about the progress and impact of climate change. Specifically, we hypothesised that those with more pro-environmental attitudes, concerns and household behaviours, would be less likely to fly, or to fly shorter distances. Cross-sectional findings on how discretionary flight behaviour is correlated with pro-environmental attitudes and household behaviour are relevant to an understanding of potential positive and negative pro-environmental 'spill-over', where an intervention may have an effect on subsequent pro-environmental behaviour which was not the behavioural target of the intervention (Truelove et al., 2014).

Our work extends previous studies examining this issue by using large and population representative UK datasets that also collected data on a large range of potential confounders. Controlling for these factors enabled us to get a far clearer picture of the independent

relationship between pro-environmentalism in general and discretionary flight behaviour in particular, for the population as a whole, than is possible in work that is unable, for instance, to account for people's financial circumstances, their attitudes to money, or their personality in general; or whose findings are based on non-representative samples.

2. Methods

2.1. Datasets

This study used secondary data from two national surveys. The CCTC Survey was conducted to inform the development of the UK Government Department for Transport segmentation model of public attitudes to climate change and transport choices. It employed a random probability sampling technique, and has data from 3923 face-to-face, in-home interviews conducted between November 2009 and June 2010 with adults (aged 16 plus) living in England (Thornton et al., 2011), (the data is available from https://www.gov.uk/government/publications/climate-change-and-transport-choices-segmentation-study-final-report). The BHPS survey was an 18-year panel survey which began in 1991 with a Wave 1 sample of 5500 households (around 10,000 individuals) selected using a two-stage clustered probability design and systematic sampling (Taylor et al., 2010). It was structured to enable the modelling of social and economic change over time at the individual and household level in Britain. Additional samples were subsequently added to the original sample to enable UK level estimates. At Wave 18, the individual questionnaire included the items relating to environmental issues which we used in this cross-sectional study. The BHPS data (available under licence through the UK Data Service) includes weights which correct for differential attrition over time, to enable individuals in each wave to be used in cross-sectional (as well as longitudinal) analyses.

2.2. Dependent variable: flight distance km count

In both the CCTC and BHPS surveys, respondents were asked to state the number of flights they had taken in the previous 12 months to destinations in each of three geographic regions: within the UK; within Europe; and outside Europe. Whilst there is not detailed information about the destinations of respondents and the distances they flew, the three regional classifications do give some information, and rather than lose this information by considering only the total number of flights, we derived the average distances of leisure flights to each geographic region by UK residents at that time, and assumed that each flight taken by respondents was of the relevant average distance. Thus, for each survey, a count scale measure of estimated km flown in the previous year was derived from responses to these questions: we multiplied the number of flights to destinations in the three regions by the average flight distance for each region, and summed the region totals. Specifically, the multiplicative constants for each region were derived by estimating the mean return distances flown by UK residents on discretionary flights from all UK departure airports to all destination airports in each region in 2008: within the UK, 857 km; within Europe, 3181 km; outside Europe, 13,518km. These estimated mean distances were calculated from routinely collected statistics (CAA, 2008a CAA, 2008b; ONS, 2009, 2014); details are given in Appendix A.

There were two important differences in how the CCTC and BHPS surveys asked respondents to state the number of flights they had taken in the previous 12 months. The CCTC counts of flights to destinations in each of the three regions were capped in the survey response options at “3/more”, and therefore counts of 3 were assumed in these cases. Secondly, whilst the BHPS asked specifically about non-work related flights, the CCTC survey asked about all flights, without distinguishing discretionary flights. We therefore examined a further CCTC survey item which recorded whether respondents had travelled more than 50 miles on business in the previous year, and treated the air travel data of all who had done so (7.9%) as potentially recording work-related flights rather than voluntary flights. These responses were therefore re-classified as missing, and the flight distance measure for these individuals was imputed (see Section 2.5 below). A sensitivity analysis compared an alternative strategy to handle the issue: the reported CCTC flight counts for those who had travelled more than 50 miles on business were instead assumed to be all discretionary flights; CCTC models with the dependent variable derived under this assumption showed no differences in substantive findings (results available on request).

2.3. Independent variables of interest: environmental variables

Key predictors derived from CCTC and BHPS variables, which were non-overlapping between the surveys (see Table 1), included: a) pro-environmental attitude (e.g., degree of agreement with statements such as “It takes too much time and effort to do things that are environmentally friendly”; CCTC scale Range 0–16, Mean = 10.33, SD = 3.52; BHPS scale Range = 0–12, Mean = 7.42; SD = 2.08); b) beliefs and concerns about climate change (abbreviated to ‘*climate concern*’, e.g., “People in the UK will be affected by climate change in the next 30 years”; CCTC scale Range = 0-6, Mean = 3.74, SD = 1.50; BHPS scale Range = 0-6, Mean = 4.47, SD = 1.72); and c) self-reported pro-environmental household behaviours (abbreviated to ‘*household behaviour*’, e.g., “How often do you switch off lights in rooms that aren't being used?”; BHPS scale Range = 0-24, Mean = 12.09, SD = 4.01). Item response sum scores (see Table 1) were used as the environmental variables and higher scores represent more pro-environmental attitudes, climate concern and household behaviour. The selection of the specific questionnaire items for deriving the environmental variables is described in Appendix A.

The distinctiveness of the ‘pro-environmental attitude’ and ‘climate change concern’ measures was investigated using principal components analysis of the items jointly comprising the two scales in each survey. Results are presented in Appendix A. For both surveys, two principal component axes with eigenvalues greater than one were identified, with pro-environmental attitude items loading more heavily on one, and climate change concern items loading more heavily on the other. Furthermore, those items loading more heavily onto Principal Component 1 had the opposite sign when they were loading onto Principal Component 2 in both surveys, and those items loading more heavily onto Principal Component 2 had the same sign when they were loading onto Principal Component 1 in both surveys. Differentiation between pro-environmental attitude and climate change concern was thus supported.

The properties of the environmental scales, and the relationships between their items, were explored using PCA separately on those items summed to derive the scale scores in each survey. Results are presented in Appendix A, where Cronbach's a statistics for internal reliability, and matrices of Pearson correlation coefficients for environmental scale items and sum scores are also shown.

Due to the novelty of the pro-environmental attitude scale that we constructed from the items in the BHPS it was important to explore the convergent construct validity against more standard measures of pro-environmentalism such as the 'Willingness to sacrifice for the environment' (Davis et al., 2011) and 'revised New Environmental Paradigm' (Dunlap et al., 2000) scales. Exploration of this is described in Appendix A; it was concluded that the scale tapped into similar latent constructs and was thus applicable to test the current research questions.

2.4. Independent control variables

In terms of individual difference controls, the BHPS questionnaire items from which we derived interval measures of relevant psychological factors (e.g., importance of money as a proxy for self-enhancement values) and personality traits, are summarised in Appendix A. Given the associations found in previous work (see Section 1.2 above) measures of religiosity, interest in politics and risk aversion were also included. Measures of the personality traits in the five factor model were derived from data in BHPS Wave 15, which was merged with the Wave 18 data. The 15-item personality inventory available in the BHPS comprises a shortened version of the inventory developed by John et al. (1991).

CCTC and BHPS questionnaire items for socio-demographic control variables (sex, age, education, labour market status, income, marital status, parenting status and disability) are mostly categorical and relatively self-evident. However, it should be noted that 'labour market status' is self-reported and includes those self-employed and on maternity leave in the 'employed' category, and includes those who are long-term sick or disabled in the 'unemployed category'; 'marital status' classifies as 'married' those currently living with a spouse or partner. There are also some slight differences in how some constructs are operationalised across the two surveys. For instance, the CCTC 'children' variable classifies 'presence of children in the household', whilst the BHPS 'children' variable classifies 'living with own (including adopted) children under the age of 16'. Further, the CCTC 'disabled' variable is based on the question "Do you have any disability or other longstanding illness that makes/would make it impossible for you to ride a bicycle?", whilst the BHPS 'disabled' variable is based on the question "Do you consider yourself to be a disabled person?" Finally, whilst the CCTC income variable is a categorical measure of gross household annual income band, the BHPS income control variable is net household annual income, adjusted for household composition.

2.5. Analytical approach

Just over 50% of participants in both samples reported no flights in the last 12 months, and thus zero miles flown. However, these individuals are likely to fall into two broad groups: a) 'Habitual non-flyers' (i.e., people who would not report flying in any given sample, perhaps

because of fear of flying or environmental reasons); and b) 'Temporary non-flyers' (i.e., people who have flown in the past, may fly again in the future but did not happen to fly during the current sampling period). Conceptually we would not expect individuals in these two groups to have the same relationship with pro-environmental attitudes, and thus to treat them both simply as 'non-flyers' would be misleading. An analogous situation might be one where we labeled all adults with no children currently residing in the household as 'non-parents', which would be to conflate those who never had children and never will (i.e., real 'non-parents') with those whose children have simply already left home. This latter group are as much in the 'parents' category as those whose children are still at home. Similarly in the current context, 'Temporary non-flyers' are as much in the 'Flyers' category as those who actually report flights in the last 12 months. To account for these kinds of situation, a statistical approach known as zero-inflated Poisson (ZIP) regression is recommended (Long and Freese, 2006).

Specifically, in the current context, the ZIP regression approach does two things. First, it has a logistic component which models the probability that an observed zero-count (i.e., no flights in the past 12 months) is contributed by: 1) an 'habitual non-flyer'; or 2) a 'temporary non-flyer'; and uses this information to model associations with being in the 'non-flyers' group (i.e., consisting of 'habitual non-flyers' only), rather than the 'flyers' group (i.e., consisting of both flyers – those who reported flying in the last 12 months – and 'Temporary non-flyers', who did not). The pro-environmental consistency hypothesis would predict that greater pro-environmentalism would be associated with greater likelihood of membership of the 'non-flyers' group.

The second component of the analysis, the Poisson component, models the number of km flown among 'flyers' (including 'Temporary non-flyers'). Here, the pro-environmental consistency hypothesis would predict that greater pro-environmentalism would be associated with flying fewer kilometres.

The outcome distribution of a zero-inflated Poisson model is defined as follows:

$$\Pr(Y=0)=\pi+(1-\pi)e^{-\lambda}$$

$$\Pr(Y=y)=(1-\pi)\frac{\lambda^{y}e^{-\lambda}}{y!},\ \text{for}\ y\geq 1$$

Where the number of miles flown Y has a non-negative integer value y, λ is the expected Poisson count, and $\boldsymbol{\pi}$ is the probability of belonging to a "non-flyer" group. To estimate the two free parameters in the above equations, λ and $\boldsymbol{\pi}$, we jointly modelled the following two regressions:

$$\log\left(\frac{\pi}{1-\pi}\right)=\alpha+\boldsymbol{B}Z+\varepsilon$$

$$\log(\lambda)=\gamma+GZ+\xi$$

Where α and γ are intercepts, $\boldsymbol{B}$ and $\boldsymbol{G}$ are vectors of the regression coefficients for common predictors Z included separately in the logistic and Poisson regressions, and ε and ξ are normally distributed error terms with separate variances. Our set of predictors Z included "pro-environmentalism" scales and, in the case of adjusted models, control variables. It is not theoretically necessary to include the same predictors Z in both regressions (i.e., we could have had Z_1 and Z_2), but here we imagined the same measured variables were relevant to both λ and $\boldsymbol{\pi}$.

Analyses were carried out using STATA 13 software. In order to make inferences about the entire population of England/UK from these analyses, rather than statements about the particular samples collected, our analyses also made use of the survey weights included in the datasets. These samples did not equally recruit from all sections of the target population for inference, and therefore analyses must accord greater weight to observations from demographic groups under-represented in the survey samples and lower weights to demographic groups who are over-represented in the samples. In the case of the CCTC this was fairly straightforward and we simply used the individual weights in the dataset to enable population representative estimates for England (Thornton et al., 2011). Estimation with the BHPS dataset was slightly more complicated and used survey estimation methods ('svy:' suite of functions in STATA software, with specification of sample strata, primary sampling units and individual weights) to additionally account for the non-random, clustered sampling method. BHPS sample members are clustered in households, and in geographic sampling units (Taylor et al., 2010), and survey regression accounts for this lack of independence of observations in the calculation of standard errors for parameter estimates. Moreover, accounting for the BHPS sampling design to enable UK national population estimates was further complicated by the fact that the BHPS panel includes a sub-sample of individuals from households in Northern Ireland which were a random sample rather than a design sample, and therefore do not have primary sampling units or strata. Consequently, observations from Northern Ireland were included in the analyses by assigning them to a further stratum, and specifying the household as the highest order clustering unit (Skinner, 1989).

Missing data due to item non-response was imputed using multiple imputation by chained equations (Azur et al., 2011). Details of imputation models and imputed data proportions are given in Appendix A. Two alternative approaches to imputation of the environmental variables were implemented. ZIP regression models using imputed (and observed) sum scale scores, were compared in sensitivity tests with estimation models in which missing values for the component items of these scales were instead imputed, and scale sum scores were subsequently derived from these imputed (and observed) item values (Azur et al., 2011).

Estimates using observed and imputed sum scale scores (as presented in Results) showed no substantive differences from estimates using sum scale scores derived from observed and imputed item scores (results available on request).

Finally, as is standard in epidemiological research, we present both unadjusted (or raw) models, and adjusted models which also include our range of covariates. The unadjusted models allow us to see the simple relationship between the predictor and outcome (which is analogous to previous studies which have only considered the relationship in isolation). By contrast, the adjusted models allow us to see whether any relationships evident in the unadjusted models remain once potential confounders (such as with income and personality) have been taken into account. Should significant relationships in the unadjusted model become non-significant in the adjusted model, this would suggest that the relationship in the unadjusted model may be driven by one or more other factors that are affecting both variables, and thus raises important concerns about any conclusions regarding the relationship estimated in the unadjusted model.

3. Results

Descriptive data on all variables under consideration are presented in Table 2. Regression results for the variables of interest are summarised in Table 3. Exponents of regression coefficients are presented, which represent, in the logistic component, Odds Ratios (OR) for being a ‘non-flyer’, and in the Poisson component, the relative flight distance (RFD) amongst ‘flyers’, associated with a unit increase, or category shift from the reference, in the predictor variables. (Full regression results, including raw coefficients in addition to their exponents, are presented in Appendix B). The models test the pro-environmental consistency hypothesis, i.e., that more pro-environmental attitudes, greater climate change concern and more pro-environmental household behaviours, would all be associated with both greater likelihood of being a ‘non-flyer’, and with reduced distance among those categorised as flyers.

3.1. Pro-environmental consistency – CCTC results

In the unadjusted model analysing the CCTC data, and contrary to the consistency hypothesis, people with higher pro-environmental attitude and climate concern scores were less likely to be ‘non-flyers’ who abstain from discretionary flights (Table 3, model 1a, OR = 0.97; 95% CI = 0.94–0.99 and OR = 0.94; 95% CI = 0.89–0.99 respectively). Once all covariates had been added to the model, however, these negative relationships became non-significant (1b). Furthermore, neither pro-environmental attitude nor climate concern was associated with estimated discretionary flight distances among ‘flyers’ in either model.

3.2. Pro-environmental consistency – BHPS results

Unadjusted (version a) and adjusted (version b) models examined associations with the following environmental variables: pro-environmental attitude and climate concern (Model 2a/b); household behaviour (Model 3a/b); pro-environmental attitude, climate concern and household behaviour (Model 4a/b).

Analysis of BHPS data echoed the CCTC findings (Table 3), with people with greater pro-environmental attitude scores being less likely to be in the ‘non-flyers’ group in the unadjusted model (model 2a, OR = 0.89; 95% CI = 0.86–0.91), though again there was no significant relationship in the adjusted model (2b). Although the odds of being a ‘non-flyer’ were significantly higher among individuals with greater climate concern in the unadjusted model (2a, OR=1.06; 95% CI = 1.03–1.09), again there was no significant relationship in the adjusted model, once factors such as employment status were controlled for (2b). Again in the unadjusted model, flight distance among those categorised as ‘flyers’ was positively related to pro-environmental attitude, suggesting that ‘greener’ individuals might actually fly more miles annually (2a, RFD = 1.02; 95% CI = 1–1.04). However, once covariates had been controlled for in the adjusted model, this relationship also became non-significant (2b).

Controlling for household behaviour did not affect any of these findings (model 4a, 4b). Without adjustment for pro-environmental attitude and climate concern, household behaviour had no significant relationships to flight behaviours in either the unadjusted or adjusted models (3a, 3b). In the model that adjusted for pro-environmental attitude and climate concern, but not the other covariates, the odds of being a ‘non-flyer’ were, supporting the pro-environmental consistency hypothesis, significantly higher among individuals who reported higher pro-environmental household behaviour scores (4a, OR =1.03; 95% CI = 1.01–1.04). Again though, once all covariates were added to the model, this finding too was rendered non-significant (4b).

3.3. Socio-demographic and psychological correlates of discretionaryflight behaviour

In terms of demographics and psychological variables (see Appendix B), individuals were significantly more likely to be categorised as ‘non-flyers’ if they were: i) aged over 66 years old (BHPS); ii) male (BHPS); iii) unemployed or caring for a relative (CCTC & BHPS); iv) unmarried (BHPS); v) disabled (CCTC & BHPS); and had: vi) children at home (CCTC & BHPS); vii) low household incomes (CCTC & BHPS); viii) few qualifications (CCTC & BHPS); and: ix) reported relatively high risk aversion, but low materialism, interest in politics, conscientiousness and extraversion (all BHPS). Distances flown, among ‘flyers’, were estimated as greater amongst those who were: i) aged under 75 years (BHPS); and had ii) no children at home (BHPS); iii) high household incomes (CCTC & BHPS); and iv) low risk aversion but high materialism and interest in politics (BHPS). The general consistency across both datasets, and with previous research (Kroesen, 2013), other datasets (CAA, 2008b), and intuitive beliefs (e.g., those with high risk aversion and from low income households fly less), provides confidence in the results and highlights the importance of considering these factors in any analysis aiming to understand the relationships between pro-environmental attitudes and discretionary flight behaviours.

3.4. Contrasting pro-environmental attitude consistency with flightand household behaviour

The lack of consistency observed between pro-environmental attitudes and climate concerns, and flight behaviour, can be contrasted with the strong consistency between pro-environmental attitude and climate concerns, and pro-environmental household behaviours in the BHPS (Table 4). Linear regression showed that both pro-environmental attitudes (b =

0.43; 95% CI = 0.38– 0.48; $p<0.001$) and climate concerns ($b = 0.16$; 95% CI = 0.1–0.22; $p < 0.001$) were positively related to household behaviour in the adjusted model (as well as in the unadjusted model). Thus, although people show pro-environmental attitude-behaviour consistency at the level of household behaviours, this did not generalise to non-work related (i.e., discretionary) flight behaviours. Of potential interest, valuing money highly, indicative of materialism and self-enhancing values, was associated with both less likelihood of being a non-flyer, and lower pro-environmental household behaviour (see Appendix B), suggesting this value, in particular, is related to a broader range of environmentally-related behaviours than may have been appreciated to date.

4. Discussion

The current research used data from two large samples, weighted to be representative of the English and UK populations respectively, to explore whether the pro-environmental consistency hypothesis extended to the issue of discretionary (non-work-related) flying behaviour. Given the well-documented environmental costs of air travel, support for the hypothesis would be found if people with more pro-environmental attitudes and greater climate concern, as well as those who engage in more pro-environmental behaviours at the household level (e.g., saving energy), should also fly less often and for shorter distances. This was first tested using simple models that did not adjust for a range of potentially confounding variables. These unadjusted models supported previous small-scale focus group work in the UK (Cohen et al., 2013; Barr et al., 2010), finding, in direct contrast to the hypothesis, that greater pro-environmental attitudes were associated with a decreased likelihood of being categorised as a ‘non-flyer’, and, in the BHPS model, an increased likelihood of flying more miles annually amongst ‘flyers’. Although individuals who had greater concern about the progress and impact of climate change were more likely to be ‘non-flyers’ in the BHPS sample, supporting pro-environmental consistency, this finding was not replicated in the CCTC sample and climate concern was not related to estimated flight distances among ‘flyers’ in either dataset.

Crucially, all of these effects were rendered non-significant in the fully-adjusted models that accounted for potentially confounding demographic and psychological factors. Moreover, the lack of any relationship between pro-environmental attitudes and concern, and flying behaviour, can be contrasted with the positive relationships between pro-environmental attitudes and climate concerns, and pro-environmental household behaviours. That is, while we found evidence for the pro-environmental consistency hypothesis at the level of household behaviours, this did not extend to discretionary flying behaviour. Although we found no robust support for pro-environmental consistency in terms of behaviour in the household and discretionary flights contexts, we also found no evidence to support the idea, suggested in one small scale mixed-methods study, that those who reported more pro-environmental household behaviours, “also tended to be those who flew furthest” (Barr et al., 2011, pp. 1234), at least in the adjusted models.

4.1. Relations of the current findings to previous work

Although a cross-sectional study design of the sort used in this work could not provide direct evidence of spill-over from initiatives aiming to encourage pro-environmental household behaviour to effects on air travel behaviour, nonetheless a positive association between pro-environmental household behaviour and air travel behaviour would be consistent with a positive pro-environmental spill-over effect. Perceived similarity between pro-environmental behaviours (Thøgersen, 2004) have been shown to be important for benign spill-over to occur. The observed lack of positive association may indicate that commonality in their environmental effects are not perceived, and they do not relate to a common social identity as an environmentalist. Assertion of a pro-environmental identity (thinking of oneself, and describing oneself as ‘pro-environmental’), is theorised as an attempt to achieve and maintain consistency in attitudes and actions across contexts, and may therefore have an important role in provoking spill-over effects across pro-environmental behaviours (Whitmarsh and O'Neill, 2010).

Similarity in the perceived difficulty of pro-environmental actions is also believed to make benign spill-over more likely (Rosentrater et al., 2013; Fujii 2006). Thus the observed lack of positive association may equally reflect the ease with which people can engage in pro-environmental household routines, in contrast to the hardship of making pro-environmental discretionary air travel choices. The possibility of negative pro-environmental spillover from household behaviour to air travel behaviour was suggested by qualitative research in which interviewees cited their pro-environmental household behaviour as a justification for discretionary air travel (Barr et al., 2010). The observed lack of negative association in the current work, however, offers no support for such a ‘moral licencing’ spill-over mechanism.

Previous research has also suggested that pro-environmental attitudes and concern have a closer relationship to household behaviour, than to air travel behaviour. Davison et al. (2014) found that combined measures of pro-environmental attitude, perceived ease of pro-environmental behaviour, and perceived personal and social pro-environmental norms, together explained two and a half times as much of the variance in intention to adapt household and routine behaviour, compared to intention to reduce flight dependency. In a study comparing groups stratified on their pro-environmental household behaviour, Barr et al. (2011) observed markedly higher self-rated concern and commitment to acton environmental matters amongst those with the most pro-environmental household behaviours, who were also the highest frequency air travellers. Our analysis using national representative samples brings into focus the issue of why pro-environmental attitudes and concern should be greater amongst those with more pro-environmental household behaviour, whilst having no relationship to more pro-environmental air travel behaviour.

The contrast we observed between consistency regarding household behaviour, and the lack of consistency regarding flight behaviour, may relate to the role of habits in directing pro-environmental behaviour. Conscious decision making, where attitudes and norms are influential in forming behavioural intentions, have been shown to play a greater role in initiating and directing behaviours which are performed only annually or biannually than in behaviour which is performed daily or weekly (Ouellette and Wood, 1998). The stability of the contexts in which household behaviours are performed, and the regular recurrence of

contextual cues, allows the development of automatic responses. There is not the same opportunity for pro-environmental discretionary air travel behaviour (i.e., abstinence or reduction) to become a habit since holiday travel is not a frequently recurring context. The occasional rather than routine nature of holiday travel may both mark it out as distinct from household behaviours and therefore prevent a positive spill-over effect, and also prevent the development of habituated behaviour.

Indeed, Cohen et al. (2013) suggest that 'breaking from routine', and even 'suspension' of norms and values, may be integral to the tourism experience, where people feel distanced from the scrutiny of their home community, and the extraordinary is anticipated. In addition, tourism is associated with conspicuous consumption, and our results are consistent with previous evidence of a significant link between income and the demand for air travel. For instance, Department for Transport (2013) estimate the income elasticity for discretionary air travel demand amongst UK nationals to be 1.4 (i.e., a 1% increase in income leads to a 1.4% increase in demand for discretionary air travel). This is similar to values for the same parameter in the US, with Intervistas Consulting Inc. (2007) finding values of 1.6–1.8. Relatedly, Kroesen (2013) found that people articulated a sense of 'necessary indulgence' to reconcile any inconsistency between their pro-environmental attitudes and flying behaviour. Thus, tourism as a setting for intrinsically non-routine and indulgent consumption which is removed from community norms, may mean that people feel little dissonance between their pro-environmental attitudes and their discretionary air travel.

4.2. Limitations and further research

We believe the consistency in our findings across two large, independent, representative datasets and across models of both propensity to fly and distances flown by flyers, provides considerable robustness to our conclusions that there is a lack of any relationship between discretionary flying behaviour and other indicators of pro-environmentalism. Nonetheless, we also recognise a number of potential limitations with the current work suggesting caution still needs to be taken. For instance, due to data availability our analyses were based on the most recent UK data available, i.e., 2009/10 (CCTC) and 2008/9 (BHPS) fieldwork. Although the successor survey to the BHPS, the UK Household Longitudinal Survey, collected data on flights during 2012/13, the survey items do not allow operationalisation of psychological constructs such as risk aversion and self-enhancing value orientation, which we know to be influential predictors of flight behaviour. Further work is thus needed, when more recent data become available, to explore whether the relationships we found might have changed over the intervening years. We see no theoretical reason why this should be, however, as the relationship between flying and GHG emissions was already widely known in 2008.

We also recognise that our estimates of flight distances are relatively crude and based on country/continental averages and that this may create a certain element of noise in our modelling of distance flown. For instance, it may be that more pro-environmental individuals choose to fly shorter distances than less pro-environmental individuals within the three geographic regions, whilst having the same counts of flight to each region, and this would not be revealed in our analyses. Even if it were true, however, that pro-

environmentalism motivated people to holiday to France from the UK rather than to Greece, for example, this would raise the question of why people who hold pro-environmental attitudes are willing to make relatively short-haul flights when other alternative forms of transport are actually more feasible than for longer haul flights. Thus although we recognise the limitations of our distance modelling, we think it was the best solution currently available, and our findings were also replicated in the logistic component of both models, which showed no relationships between other forms of pro-environmentalism and whether or not individuals were categorised as ‘flyers’ or ‘non-flyers’. Nonetheless, future work would benefit from more accurate annual flight data at the individual level.

Finally, our use of archive data did not enable us to test traditional pathway models of pro-environmental behaviours (see Section 1.2) because operationalisations of all the relevant constructs were not available. Further research using representative samples is now needed that includes operationalisations of the constructs in these theories to better explore the relationships between pro-environmental related values, norms, attitudes, beliefs, goals, emotions, objective and subjective constraints, and intentions, to better understand the antecedents of discretionary flight behaviour. Further, such studies would ideally be conducted in multiple countries to explore whether our UK findings extend to other countries where pro-environmental consistency may be higher (e.g., Germany, Bamberg, 2013a).

4.3. Conclusions and policy implications

In sum, although we found support for the pro-environmental consistency hypothesis with respect to attitudes and household behavioursin two large representative samples, this did not extend to discretionary flying behaviour. Our findings thus offer little support for a policy approach that relies on improving pro-environmental attitudes, awareness of climate change outcomes and encouraging routine pro-environmental household behaviours, in the hope that this will have positive spill-over effects in terms of a reduction in discretionary air travel (Austin et al., 2011). This suggests that other actions should be considered including the use of economic instruments or regulatory controls to reduce discretionary air travel based emissions instead. Overall, price elasticities for leisure travellers are assumed to be more elastic than those for business travel (Smyth and Pearce, 2008), so increasing prices through taxation or other means is likely to reduce demand, and hence emissions. Policy actions could be at national level (e.g., increasing air passenger duty or introducing aviation fuel duty for domestic flights) or international (e.g., through extension of the EU Emissions Trading Scheme on aviation emissions), or through market based measures developed under the UN's International Civil Aviation Organization.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The contributions of IA, MW, TT, SV and LF were funded by the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Environmental Change and Health at the London School of Hygiene and Tropical Medicine in partnership with Public Health England (PHE), and in collaboration with the University

of Exeter, University College London, and the Met Office. Neither the BHPS data collectors nor the UK Data Archive bear any responsibility for the analyses or interpretations presented here. DFC was funded by a studentship grant awarded to KLE from the Biodiversity and Ecosystem Service Sustainability (BESS) programme, funded by the UK Natural Environment Research Council (NERC) and the Biotechnology and Biological Sciences Research Council (BBSRC) as part of the UK's Living with Environmental Change (LWEC) programme. The contributions of MOG were supported in part by a P30 Core Center Grant (P30 ES019776) from the National Institute for Environmental Health Sciences (NIEHS) to Emory University. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, the Department of Health, Public Health England, the BESS Directorate or NERC.

References

Ajzen I. The theory of planned behaviour. Organ Behav Hum Decis Process. 1991; 50:179–211.

Anable J. 'Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory. Transport Policy. 2005; 12:65–78.

Austin, A., Cox, J., Barnett, J., Thomas, C. Brook Lyndhurst for DEFRA. London: 2011. Exploring Catalyst Behaviours: Full Report. A Report to the Department for Environment, Food and Rural Affairs.

Azur MJ, Stuart EA, Frangakis C, Leaf PJ. Multiple imputation by chained equations: what is it and how does it work? Int J Methods Psychiatr Res. 2011; 20:40–49. [PubMed: 21499542]

Bamberg S. Changing environmentally harmful behaviors: a stage model of self-regulated behavioral change. J Environ Psychol. 2013a; 34:151–159.

Bamberg S. Applying the stage model of self-regulated behavioral change in a car use reduction intervention. J Environ Psychol. 2013b; 33:68–75.

Barile L, Cullis J, Jones P. Will one size fit all? Incentives designed to nurture prosocial behaviour. J Behav Exp Econ. 2015; 57:9–16.

Barr S, Shaw G, Coles T, Prillwitz J. A holiday is a holiday: practicing sustainability, home and away. J Transport Geogr. 2010; 18:474–481.

Barr S, Shaw G, Coles T. Times for (Un)sustainability? Challenges and opportunities for developing behaviour change policy: a case-study of consumers at home and away. Glob Environ Change. 2011; 21:1234–1244.

Bohr J. Barriers to environmental sacrifice: the interaction of free rider fears with education, income, and ideology. Sociol Spectr. 2014; 34:362–379.

CAA. UK Airport Statistics: 2008: T. 12.1 Intl Air Pax Route Analysis 2008/12.2 Dom Air Pax Route Analysis 2008. 2008a. Available online from http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=3&fld=2008Annual

CAA. CAA Passenger Survey Report 2008: Survey of passengers at Bristol, Cardiff, Exeter, Gatwick, Heathrow, London City, Luton, Manchester and Stansted Airports. CAA, Economic Regulation group (2008). 2008b. Available online from http://www.caa.co.uk/docs/81/2008CAAPaxSurveyReport.pdf

Cabinet Office. Cabinet Office. London: 2011. Behavioural insights team annual update 2010–2011.

Cairns, S., Newson, C. Predict and Decide: Aviation, Climate Change and Policy. UKERC; Oxford (Demand Reduction Theme): 2006.

Chen X, Peterson MN, Hull V, Lu C, Lee GD, Hong D, Liu J. Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in urban China. Environ Conserv. 2011; 38:45–52.

Cohen SA, Higham JES, Reis AC. Sociological barriers to developing sustainable discretionary air travel behaviour. J Sustain Tourism. 2013; 21:982–998.

Corner A, Markowitz E, Pidgeon N. Public engagement with climate change: the role of human values. Wiley Interdiscip Rev Clim Change. 2014; 5:411–422.

DEFRA. The Sustainable Lifestyles Framework. 2011. Available online from http://webarchive.nationalarchives.gov.uk/20130822084033/http://archive.defra.gov.uk/environment/economy/documents/sustainable-life-framework.pdf

Davis JL, Le B, Coy AE. Building a model of commitment to the natural environment to predict ecological behavior and willingness to sacrifice. J Environ Psychol. 2011; 31:257–265.

Davison L, Littleford C, Ryley T. Air travel attitudes and behaviours: the development of environment-based segments. J Air Transport Manage. 2014; 36:13–22.

De Groot JIM, Steg L. Value orientations to explain beliefs related to environmental significant behavior: how to measure egoistic, altruistic, and biospheric value orientations. Environ Behav. 2008; 40:330–354.

Department for Transport. UK Aviation Forecasts. 2013 Jan. 2013. Available online from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

Diamantopoulos A, Schlegelmilch BB, Sinkovics RR, Bohlen GM. Can socio-demographics still play a role in profiling green consumers? A review of the evidence and an empirical investigation. J Bus Res. 2003; 56:465–480.

Dietz T, Fitzgerald A, Shwom R. Environmental values. Annu Rev Environ Resour. 2005; 30:335–372.

Dubois G, Ceron JP. Tourism/leisure greenhouse gas emission forecasts for 2050: factors for change in France. J Sustain Tourism. 2006; 14:172–191.

Dunlap RE, Van Liere KD, Mertig AG, Jones RE. New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale. J Soc Issues. 2000; 56:425–442.

Evans L, Maio G, Corner A, Hodgetts CJ, Ahmed S, Hahn U. Self-interest and pro-environmental behaviour. Nat Clim Change. 2012; 3:122–125.

Fraj E, Martinez E. Influence of personality on ecological consumer behaviour. J Consum Behav. 2006; 5:167–181.

Fujii S. Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. J Environ Psychol. 2006; 26:262–268.

Gössling S, Peeters P. 'It does not harm the environment!' an analysis of industry discourses on tourism, air travel and the environment. J Sustain Tourism. 2007; 15:402–417.

Gössling, S., Upham, P., editors. Aviation and Climate Change: Issues, Challenges and Solutions. Earthscan, London; Stirling VA: 2009.

Gallet CA, Doucouliagos H. The income elasticity of air travel: a meta-analysis. Ann Tourism Res. 2014; 49:141–155.

Gifford R, Nilsson A. Personal and social factors that influence pro-environmental concern and behaviour: a review. Int J Psychol. 2014; 49:141–157. [PubMed: 24821503]

Hirsh JB, Dolderman D. Personality predictors of consumerism and environmentalism: a preliminary study. Personal Individ Dif. 2007; 43:1583–1593.

Hirsh JB. Personality and environmental concern. J Environ Psychol. 2010; 30:245–248.

House of Lords. Science and Technology Committee Second Report. Behaviour Change. 2011. Available online from http://www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/179/17902.htm

Hunter LM, Hatch A, Johnson A. Cross-national gender variation in environmental behaviors. Soc Sci Q. 2004; 85:677–694.

IATA. Global Report. International Air Transport Association; 2014. Air Passenger Forecasts.

Intervistas Consulting Inc. Estimating Air Travel Demand Elasticities. Final Report Prepared for IATA. 2007 Dec 28. 2007. Available online from https://www.iata.org/whatwedo/Documents/economics/Intervistas_Elasticity_Study_2007.pdf

John, OP., Srivastava, S. The Big Five trait taxonomy: history, measurement, and theoretical perspectives. In: John, OP., Pervin, LA., editors. Handbook of Personality: Theory and Research. 2nd. Guilford Press; New York: 1999. p. 114-158.

John, OP., Donahue, EM., Kentle, RL. The Big Five Inventory- Versions 4a and 54. University of California, Berkley, Institute of Personality and Social Research, Berkley; 1991.

Joireman JA, Lasane TP, Bennett J, Richards D, Solaimani S. Integrating social value orientation and the consideration of future consequences within the extended norm activation model of proenvironmental behaviour. Br J Soc Psychol. 2001; 40:133–155. [PubMed: 11329831]

Kemmelmeier M, Kròl G, Young HK. Values, economics, and proenvironmental attitudes in 22 societies. Cross Cult Res. 2002; 36:256–285.

Klöckner CA, Blöbaum A. A comprehensive action determination model –towards a broader understanding of conservationist behaviour. J Environ Psychol. 2010; 30:574–586.

Kroesen M. Exploring people's viewpoints on air travel and climate change: understanding inconsistencies. J Sustain Tourism. 2013; 21:271–290.

Long, JS., Freese, J. Regression Models for Categorical Dependent Variables Using Stata. 2nd. Stata Press; College Station, TX: 2006.

Longhi, S. Individual pro-environmental behaviour in the household context. ISER Working Paper No 2013-21. 2013. Available online from https://www.iser.essex.ac.uk/research/publications/working-papers/iser/2013-21.pdf

Lorenzoni I, Nicholson-Cole S, Whitmarsh L. Barriers perceived to engaging with climate change among the UK public and their policy implications. Glob Environ Change. 2007; 17:445–459.

Markowitz EM, Goldberg LR, Ashton MC, Lee K. Profiling the 'pro-environmental individual': a personality perspective. J Personal. 2012; 80:81–111.

Martinussen, M., Hunter, DR. Aviation Psychology and Human Factors. Taylor and Francis; London: 2009.

McKercher B, Prideaux B, Cheung C, Law R. Achieving voluntary reductions in the carbon footprint of tourism and climate change. J Sustain Tourism. 2010; 18:297–317.

Milfont TL, Sibley CG. The big five personality traits and environmental engagement: associations at the individual and societal level. J Environ Psychol. 2012; 32:187–195.

Milfont TL, Milojev P, Greaves L, Sibley CG. Socio-structural and psychological foundations of climate change beliefs. N Z J Psychol. 2015; 44:17–30.

O'Connor RE, Bord RJ, Fisher A. Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Anal. 1999; 19:461–471.

ONS. International Passenger Survey, 2008 (SN5993). Office for National Statistics. Social and Vital Statistics Division. (2009). International Passenger Survey, 2008. [data collection]. 5th2009. UK Data Service. SN: 5993. data available from https://discover.ukdataservice.ac.uk/catalogue/?sn=5993&type=Data%20catalogue

ONS. International Passenger Survey. Overseas Travel and Tourism. User Guide (Volume 1) Background & Methodology. 2014. Available online from http://www.ons.gov.uk/ons/guide-method/method-quality/specific/travel-and-transport-methodology/international-passenger-survey-methodology/index.html

Oreg S, Katz-Gerro T. Predicting proenvironmental behavior cross-nationally: values, the theory of planned behavior, and value-belief-norm theory. Environ Behav. 2006; 38:462–483.

Ortega-Egea JM, Garcìa-de-Frutos N, Antolìn-Lòpez R. Why do some people do "more" to mitigate climate change than others? Exploring heterogeneity in psycho-social associations. PLoS One. 2014; 9:e106645. [PubMed: 25191841]

Ouellette JA, Wood W. Habit and intention in everyday life: the multiple processes by which past behaviour predicts future behaviour. Psychol Bull. 1998; 124:54–75.

Paladino A. Understanding the green consumer: an empirical analysis. J Customer Behav. 2005; 4:69–102.

Pepper M, Jackson T, Uzzell D. An examination of Christianity and socially conscious and frugal consumer behaviors. Environ Behav. 2011; 43:274–290.

Plog SC. Why destination areas rise and fall in popularity: an update of a Cornell quarterly classic. Cornell Hotel Restaur Adm Q. 2001; 42:13–24.

Randles S, Mander S. Aviation, consumption and the climate change debate: are you going to tell me off for flying? Technol Anal Strat Manage. 2009; 21:93–113.

Rosentrater LD, Sælensminde I, Ekström F, Böhm G, Bostrom A, Hanss D, O'Connor RE. Efficacy trade-offs in individuals' support for climate change policies. Environ Behav. 2013; 45:935–970.

Schwartz, SH. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. In: Zanna, MP., editor. Adv Exp Soc Psychol. Vol. 25. Academic Press; New York: 1992. p. 1-65.

Schwartz SH. Are there universal aspects in the structure and contents of human values? J Soc Issues. 1994; 50:19–45.

Skinner, CJ. Introduction to part a. In: Skinner, CJ.Holt, D., Smith, TMF., editors. Analysis of Complex Surveys. John Wiley & Sons; Chichester: 1989. p. 23-58.

Smyth, M., Pearce, B. IATA Economics Briefing No 9. IATA; 2008. Air Travel Demand: Measuring the responsiveness of air travel demand to changes in prices and incomes.

Steg L, Vlek C. Encouraging pro-environmental behaviour: an integrative review and research agenda. J Environ Psychol. 2009; 29:309–317.

Stern PC. Toward a coherent theory of environmentally significant behavior. J Soc Issues. 2000; 56:407–424.

Swami V, Chamorro-Premuzic T, Snelgar R, Furnham A. Personality, individual differences, and demographic antecedents of self-reported household waste management behaviours. J Environ Psychol. 2011; 31:21–26.

Taylor, MF., Brice, J., Buck, N., Prentice-Lane, E. British Household Panel Survey User Manual Vol A: Introduction, Technical Report and Appendices. University of Essex; Colchester, UK: 2010.

Thøgersen J, Ölander F. To what degree are environmentally beneficial choices reflective of a general conservation stance? Environ Behav. 2006; 38:550–569.

Thøgersen J. A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior. J Environ Psychol. 2004; 24:93–103.

Thornton, A., Evans, L., Bunt, K., Simon, A., King, S., Webster, T. Climate Change and Transport Choices. Segmentation Model – A framework for reducing CO2 emissions from personal travel. 2011. Available online from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/49971/climate-change-transport-choices-full.pdf

Torgler, B., Garcia-Valiñas, MA. Fondazione Eni Enrico Mattei (FEEM) Working Paper Series No 110 05. Milano: 2005. The Determinants of Individuals' Attitudes Towards Preventing Environmental Damage.

Truelove HB, Carrico AR, Weber EU, Raimi KT, Vandenbergh MP. Positive and negative spillover of pro-environmental behavior: an integrative review and theoretical framework. Glob Environ Change. 2014; 29:127–138.

Umpfenbach, K. colleagues. Final Report for the European Commission (DG Environment), 8 April 2014. Ecologic Institute; Berlin: 2014. Influences on Consumer Behaviour: Policy implications beyond nudging. Available online from http://ec.europa.eu/environment/enveco/economics_policy/pdf/Behaviour%20Policy%20Brief.pdf

Van Renssen S. Climate battle for the skies. Nat Clim Change. 2012; 2:308–309.

Whitmarsh L, O'Neill S. Green identity, green living? The role of proenvironmental self-identity in determining consistency across diverse proenvironmental behaviours. J Environ Psychol. 2010; 30:305–314.

Whitmarsh L. Scepticism and uncertainty about climate change: dimensions, determinants and change over time. Glob Environ Change. 2011; 21:690–700.

Table 1

CCTC and BHPS component items in environmental variable scale sum scores.

Scale	Survey	Scale component item	Item response (item score)
Pro-environmental attitude	CCTC	There is too much concern with the environment.	Definitely agree (0); Tend to agree (1); Neither agree nor disagree (2); Tend to disagree (3); Definitely disagree (4)
		It's only worth doing environmentally-friendly things if they save you money.	Definitely agree (0); Tend to agree (1); Neither agree nor disagree (2); Tend to disagree (3); Definitely disagree (4)
		I don't have time to worry about my impact on the environment.	Definitely agree (0); Tend to agree (1); Neither agree nor disagree (2); Tend to disagree (3); Definitely disagree (4)
		I find it hard to change my habits to be more environmentally-friendly.	Definitely agree (0); Tend to agree (1); Neither agree nor disagree (2); Tend to disagree (3); Definitely disagree (4)
	BHPS	It takes too much time and effort to do things that are environmentally friendly.	Strongly agree (0); Agree (1); Neither agree nor disagree (2); Disagree (3); Strongly disagree (4)
		Scientists will find a solution to global warming without people having to make big changes to their lifestyle.	Strongly agree (0); Agree (1); Neither agree nor disagree (2); Disagree (3); Strongly disagree (4)
		The environment is a low priority compared with a lot of other things.	Strongly agree (0); Agree (1); Neither agree nor disagree (2); Disagree (3); Strongly disagree (4)
Climate concern	CCTC	Thinking about the effects of climate change, which of the following best describes your views?	Climate change will have an impact on other countries, but not on the UK (0); Climate change is not happening/will not have an impact on the UK or other countries (0); Climate change will have less of an impact on the UK than on other countries (1); Climate change will have as much of an impact on the UK as on other countries (2)
		How concerned are you about climate change?	Very unconcerned (0); Fairly unconcerned (0); Neither concerned nor unconcerned (0); Fairly concerned (1); Very concerned (2)
		Thinking about the effects of climate change, which of the following best describes your views?	Climate change will not have a real impact in my lifetime, but will have a real impact on future generations (0); Climate change is not happening/will never have a real impact (0); Climate change is not yet having a real impact, but will do in my lifetime (1); Climate change is already having a real impact (2)
	BHPS	Do you personally believe:	'Extensive and long-lasting flooding caused by climate change is likely to take place in the UK - No' & 'Extensive and long-lasting flooding caused by climate change is likely to take place in low-lying countries like Bangladesh or the Netherlands - No' (0); 'Extensive and long-lasting flooding caused by climate change is likely to take place in the UK - No' & 'Extensive and long-lasting flooding caused by climate change is likely to take place in low-lying countries like Bangladesh or the Netherlands - Yes' (1); 'Extensive and long-lasting flooding caused by climate change is likely to take place in the UK - Yes' (2)
		Do you personally believe:	'Climate change is likely to cause severe food shortages in the UK - No' & 'Climate change is likely to cause severe food shortages in places like Africa and India - No' (0); 'Climate change is likely to cause severe food shortages in the UK - No' & 'Climate change is likely to cause severe food shortages in places like Africa and India - Yes'(1); 'Climate change is likely to cause severe food shortages in the UK - Yes' (2)
		Do you personally believe:	'People in the UK will be affected by climate change in the next 30 years - No' & 'People in the UK will be affected by climate change in the next 200 years - No' (0); 'People in the UK will be affected by climate change in the next 30 years - No' & 'People in the UK will be affected by climate change in the next 200 years - Yes' (1); 'People in the UK will be affected by climate change in the next 30 years -Yes' (2)

Scale	Survey	Scale component item	Item response (item score)
Household behaviour	BHPS	How often do you personally switch off lights in rooms that aren't being used?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)
		How often do you personally put more clothes on when you feel cold rather than putting the heating on or turning it up?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)
		How often do you personally decide not to buy something because you feel it has too much packaging?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)
		How often do you personally buy food that has been produced locally?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)
		How often do you personally buy recycled paper products such as toilet paper or tissues?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)
		How often do you personally take your own shopping bag when shopping?	Always (4); Very often (3); Quite often (2); Not very often (1); Never (0)

Table 2

Descriptive data on the CCTC and BHPS samples.

	Climate Change and Transport Choices sample			British Household Panel Survey sample		
	Scale range	**Population mean (SE) (SD)**	**Population% (SE)**	**Scale range**	**Population mean (SE) (SD)**	**Population% (SE)**
Environmental variables						
Flight distance (thousand km)		5.89 (0.25) (11.19)			5.95 (0.2) (15.47)	
Flight distance category						
0km			52.15 (1)			50.32 (0.78)
>0 – < = 5000 km			18.12 (0.81)			20.21 (0.54)
>5000 – < = 10000 km			10.57 (0.61)			9.83 (0.42)
>10000 – < = 20000 km			10.17 (0.61)			13.24 (0.5)
>20000 km			8.98 (0.58)			6.39 (0.36)
Pro-environmental attitudes	0–16	10.33 (0.07) (3.52)		0–12	7.42 (0.03) (2.08)	
Climate concern	0–6	3.74 (0.03) (1.50)		0–6	4.47 (0.02) (1.72)	
Household behaviour	–	–	–	0–24	12.09 (0.07) (4.01)	
Psychological variables						
Religiosity	–	–	–	0–3	0.96 (0.02) (1.08)	
Interest in politics	–	–	–	0–3	2.27 (0.014) (0.93)	
Importance of money	–	–	–	0–9	5.48 (0.03) (1.92)	
Risk aversion	–	–	–	0–9	4.51 (0.02) (2.17)	
Socio-demographic characteristics						
Female			51.12 (0.97)			53.23 (0.39)
Age (years) (CCTC/BHPS)						
age 16–20/16–25			8.04 (0.62)			14.45 (0.48)
age 21–29/26–35			15.40 (0.78)			12.88 (0.47)
age 30–39/36–45			16.60 (0.71)			18.43 (0.56)
age 40–49/46–55			18.51 (0.74)			16.82 (0.45)
age 50–59/56–65			14.87 (0.69)			15.78 (0.45)
age 60–69/66–75			12.86 (0.57)			11.54 (0.43)
age over 69/over 75			13.72 (0.57)			10.10 (0.43)
Educational qualifications						

Glob Environ Change. Author manuscript; available in PMC 2018 January 01.

	Climate Change and Transport Choices sample			British Household Panel Survey sample		
	Scale range	**Population mean (SE) (SD)**	**Population% (SE)**	**Scale range**	**Population mean (SE) (SD)**	**Population% (SE)**
no/low qualifications			27.38 (0.79)			24.39 (0.61)
GCSE qualifications			22.56 (0.84)			15.55 (0.46)
A level qualifications			21.44 (0.91)			12.12 (0.43)
diploma qualifications			8.45 (0.44)			32.92 (0.60)
degree qualifications			20.16 (0.75)			15.01 (0.55)
Labour market status						
employed			57.60 (0.94)			57.35 (0.66)
unemployed			7.02 (0.48)			6.62 (0.33)
retired			22.34 (0.71)			25.34 (0.65)
in education			7.11 (0.60)			5.58 (0.31)
family carer			5.93 (0.44)			5.11 (0.27)
Net household annual income (£)		–			26,017 (252) (14,986)	
Gross household annual income (£)						
under 12,499			23.57 (0.91)			–
12,500 to 19,999			17.22 (0.93)			–
20,000 to 34,999			24.28 (1.01)			–
35,000 to 59,999			21.16 (1.06)			–
over 59,999			13.78 (0.85)			–
Married/co-habiting			64.62 (0.91)			63.73 (0.66)
Children			34.31 (0.95)			25.11 (0.71)
Disability			9.73 (0.49)			10.55 (0.34)
Personality traits						
Agreeableness trait	–	–	–	0–18	13.19 (0.04) (2.98)	
Conscientiousness trait	–	–	–	0–18	12.70 (0.04) (3.24)	
Extraversion trait	–	–	–	0–18	9.46 (0.04) (3.01)	
Neuroticism trait	–	–	–	0–18	7.94 (0.05) (3.88)	
Openness trait	–	–	–	0–18	10.41 (0.05) (3.59)	

Glob Environ Change. Author manuscript; available in PMC 2018 January 01.

Table 3

Results of Zero-inflated Poisson regression models predicting:a)Odds ratios associated with being an‘habitual non-flyer’ vs. ‘flyer’ (logistic equation model component); and b) Relative flight distance among ‘flyers’ (Poisson equation model component).

	Climate Change and Transport Choices sample		British Household Panel Survey sample					
	Model 1a Unadjusted model	Model 1b Adjusted model[a]	Model 2a Unadjusted model	Model 2b Adjusted model[a,b]	Model 3a Unadjusted model	Model 3b Adjusted model[a,b]	Model 4a Unadjusted model	Model 4b Adjusted model[a,b]
	OR/RFD; (95% CI)	OR/RFD; (95% CI)	OR/RFD (95% CI)	OR/RFD (95% CI)	OR/RFD (95% CI)	OR/RFD (95% CI)	OR/RFD (95% CI)	OR/RFD; (95% CI)
a) Association with being a ‘non-flyer’								
Pro-environmental attitude	0.97** (0.94–0.99)	0.98 (0.96–1.01)	0.89*** (0.86–0.91)	0.98 (0.95–1.01)	–	–	0.87*** (0.85–0.90)	0.97† (0.95–1.00)
Climate concern	0.94* (0.89–0.99)	0.97 (0.92–1.04)	1. 0 6*** (1.03–1.09)	1.02 (0.98–1.05)	–	–	1.05** (1.02–1.09)	1. 01 (0.98–1.05)
Household behaviour	–	–	–	–	1. 01† (1.00–1.03)	1. 0 1 (0.99–1.02)	1.03*** (1.01–1.04)	1. 01 (0.99–1.03)
b) Relative flight distance, ‘Flyers’ only								
Pro-environmental attitude	1.0 0 (0.98–1.02)	0.99 (0.97–1.01)	1.02* (1.00–1.04)	1. 0 0 (0.98–1.02)	–	–	1.02* (1.00–1.04)	1. 0 0 (0.98–1.02)
Climate concern	1.02 (0.98–1.07)	1. 01 (0.97–1.06)	0.98 (0.96–1.01)	0.99 (0.97–1.02)	–	–	0.98 (0.96–1.01)	0.99 (0.97–1.02)
Household behaviour	–	–	–	–	1.00 (0.99–1.01)	1.0 0 (0.98–1.01)	1.0 0 (0.99–1.01)	1. 0 0 (0.98–1.01)

[a] adjusted for sex, age, education, labour market status, income, marital status, parental status, disability.

[b] further adjusted for social values: religiosity, interest in politics, importance of money, risk aversion; and personality traits: agreeableness, conscientiousness, extraversion, neuroticism, openness. OR=Odds ratio (model component a), RFD=Relative flight distance (model component b).

† p<0.1.

* p<0.05.

** p<0.01.

*** p<0.001.

Glob Environ Change. Author manuscript; available in PMC 2018 January 01.

Table 4

Results of zero-inflated Poisson regression model of flight distance, and linear regression model of household behaviour, (BHPS sample).

	ZIP regression model of flight distance[a]						Linear regression model of pro-environmental household behaviour[a]		
	Association with being a 'non-flyer'			Flight distance among 'eligible flyers'					
	Coefficient	SE	p	Coefficient	SE	p	Coefficient	SE	p
Environmental variables									
Pro-environmental attitude	−0.02	0.01	0.121	0.00	0.01	0.903	0.43	0.03	<0.001
Climate concern	0.02	0.02	0.383	−0.01	0.01	0.689	0.16	0.03	<0.001

[a]adjusted for sex, age, education, labour market status, income, marital status, parental status, disability, religiosity, interest in politics, importance of money, risk aversion, agreeableness, conscientiousness, extraversion, neuroticism, openness.