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AN EXAMINATION OF THE EFFECTS OF LOSS AVERSION ON PRO-ENVIRONMENTAL DECISIONS

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To my family.

SUMMARY

With the threat of climate change pressing down on us, impacting everything we know – from the economy, physical safety and food security, to the natural eco-systems around us – action from all stakeholders is needed urgently. In the nexus between technology, policy, business and individual behaviour, this thesis focuses on the latter. It may not be the most impactful on a small scale, but – just as little drops of water make up the mighty ocean – small change on a big scale can contribute importantly towards mitigating climate change and safeguarding environmental sustainability.

Situated in behavioural environmental economics, this dissertation turns to prospect theory to test how we could encourage pro-environmental behaviour. Concretely, I examine the effects of loss aversion on pro-environmental decisions: stated preferences and action. This is both theoretically interesting – since environmentally-relevant decisions are unique in character and somewhat removed from the monetary gambles prospect theory was developed around – and of practical use. Indeed, the assumption is that leveraging loss aversion through loss framing of environmental appeals will work to subconsciously trigger pro-environmental behaviour. This thesis investigates this assumption both theoretically and empirically.

In the theoretical component, I provide the reader an introduction to the concept of loss aversion, the theories it is tied with – prospect theory, dual process theory and nudge theory – and how they relate to environmental decision-making. The next theoretical section dives into loss aversion: how it relates to environmental goods and how it can be extended in practice – through loss framing, default bias and the endowment effect. Focusing on the first, I then provide a systematic literature review of loss framing on pro-environmental decisions. The review showed that loss framing was indeed more often effective than gain framing in triggering pro-environmental intentions and behaviour. It also exposed a worrying gap in the literature: only 7 of the 61 studies reviewed measured real behaviour; the rest focused on stated preferences, such as attitudes, intentions and willingness to pay. Since such self-report measures suffer from social desirability bias and poor memory recall, relying on them for understanding pro-environmental behaviour is troubling. This is a recurring theme of the thesis and is explored again in the results and discussion chapters.

The contextual focus of this dissertation is travel and tourism. With a two-way relationship with environmental sustainability – being both strong contributors to global greenhouse gas emissions and impacted by climate change in turn – travel and tourism are particularly interesting and demand special attention. The third section of chapter 2 therefore provides a birds-eye introduction to environmental sustainability research in this area, focusing on the empirical research of relevance to this thesis. As a prequel to the empirical study explored in the following chapters, the final section presents a comprehensive review of the literature on the chosen pro-environmental behaviour in tourism in focus – voluntary carbon offsetting.

The empirical component is a real-behaviour online experiment on the effect of framing on voluntary carbon offsetting. In an incentive-compatible randomised controlled trial, I present

three groups of participants with slightly different descriptions of voluntary carbon offsetting. Following a real effort task, with which they could earn money to buy an offset – a novelty for pro-environmental behaviour in tourism – the subjects were asked to choose whether to donate this money or collect it instead. This was either followed or preceded by questions on attitude towards voluntary carbon offsetting, depending on the survey order – a measure taken to minimise common method bias. Questions on participant psychographics, habits and socio-demographics followed. To better prepare for the experiment, a mixed-methods pre-test was conducted, including a focus group, a screening survey and two-rounds of pilot experiments.

The results show that loss framing was not quite as successful as previous literature suggests. This may be because the behavioural decision in this experiment carried a financial cost to the participant, whereas in previous real behaviour studies the cost was in the form of time or effort. Loss framing did have the theory-predicted statistically significant effect on voluntary carbon offsetting behaviour, but only in the original survey order: participants that read a loss-framed message were more likely than their counterparts in the gain treatment or control to allocate their earnings to purchasing an offset. This was not the case in the inverse survey order, in which questions on attitudes came before the offsetting decision. One explanation for this can be drawn from dual process theory: loss framing only worked as a System 1 nudge, targeting subconscious and automatic decision-making processes; if questions on attitudes were asked after first, the decision became more reflective and loss framing lost its effect.

A second important finding from the experiment is that there is a tangible gap between intentions and behaviour. This result may serve as a warning to researchers against relying on measures of behavioural intention as (one-to-one) indicators of actual behaviour. The results also point to a gap between attitudes towards voluntary carbon offsetting and offsetting behaviour: not only were positive attitudes not always associated with the behaviour, for a number of participants negative attitudes *were*. This suggests positive attitudes are not a pre-requisite for pro-environmental behaviour, a finding that contradicts implicit assumptions in literature that leans on the theory of planned behaviour.

The discussion that follows provides a theoretical explanation for the hypotheses results and lists the methodological, practical and theoretical contributions of the thesis. Further to the strengths and value added presented within this summary already, this thesis also contributes some useful ideas for implementation in practice. I suggest to policy makers to utilise in their environmental appeals loss framing – that is, to highlight the negative consequences on the environment of not carrying out some desired action. This nudge may be particularly effective, I argue, when placed directly (temporarily and/or physically) adjacently to the behaviour in question, and when combined with other interventions, such as financial incentives. After all, for the complex challenge that is environmental sustainability, a multitude of different approaches and measures can be relied on to work best.

Key words: loss aversion, loss framing, attitude-behaviour gap, pro-environmental behaviour, sustainable tourism

POVZETEK

V luči vse večje grožnje podnebnih sprememb, ki vplivajo na vse okoli nas – od gospodarstva, fizične in prehranske varnosti do ekosistemov, ki nas obdajajo –, so potrebni takojšnji ukrepi s strani vseh deležnikov: tehnologije, politike, gospodarstva ter posameznikov. Pričujoča doktorska disertacija se v tej verigi osredotoča prav na slednje. Četudi posamezno vedenje nima največjega vpliva, lahko majhne spremembe velikega števila posameznikov pomembno prispevajo k ublažitvi podnebnih sprememb in zaščiti okoljske trajnosti.

Pričujoča disertacija izhaja iz okoljske vedenjske ekonomije in se naslanja na teorijo obetov (*angl.* prospect theory) za preučitev možnosti spodbujanja okolju prijaznega vedenja. Osredotočam se na vpliv nenaklonjenosti izgubi (*angl.* loss aversion) na okolju prijazne odločitve, ki tu vključujejo izražene preference in dejansko vedenje. Gre tako za praktično uporabno kot tudi teoretično zanimivo vprašanje. Namreč za okolje relevantno odločanje je znano, da je po naravi svojevrstno in precej oddaljeno od denarnih odločitev, na podlagi katerih je bila teorija obetov prvotno razvita. Predpostavljam, da bo uporaba nenaklonjenosti izgubi skozi okvirjanje izgube (*angl.* loss framing) pozitivno podzavestno vplivala na okolju prijazno vedenje. V pričujoči disertaciji preverjam to tezo tako teoretično kot tudi empirično.

V teoretičnem delu bralcu predstavim koncept nenaklonjenosti izgubi in teorije, s katerimi je povezan – teorija obetov, teorija dvojnega procesiranja (*angl.* dual process theory) in teorija dregljaja (*angl.* nudge theory) –, ter kako so te teorije povezane z okolju relevantnim odločanjem. Nato se poglobim v nenaklonjenost izgubi: kako je povezana z okoljskimi dobrinami in kako jo je mogoče implementirati v praksi – prek okvirjanja izgube, pristranskosti privzete izbire (*angl.* default bias) in učinka lastništva (*angl.* endowment effect). Osredotočim se na prvo od teh treh in predstavim sistematičen pregled literature o vplivu okvirjanja izgube na okolju prijazne odločitve. Pregled literature je pokazal, da je bilo okvirjanje izgube res pogosteje učinkovito kot okvirjanje koristi pri sprožanju okolju prijaznih namenov in vedenja. Razkril pa je tudi skrb vzbujajočo vrzel v literaturi: le 7 od 61 pregledanih študij je merilo dejansko vedenje, medtem ko so preostale bile osredotočene na izražene preference, kot so stališča, nameni in pripravljenost za plačilo (*angl.* willingness to pay). Šibkost meril, ki so podana na podlagi lastnih ocen, so med drugim slab spomin in pristranskosti, povezane z družbeno zaželenostjo, zato je zanašanje nanje pri razumevanju okoljskega vedenja skrb vzbujajoče. To je ponavljajoča se tema disertacije, v katero se poglobim tudi v poglavjih Rezultati in Diskusija.

Disertacija se osredotoča na kontekst potovanj in turizma. Turistična panoga je še posebej zanimiva in zahteva posebno pozornost zaradi svojega dvosmernega odnosa z okoljsko trajnostjo: potovanja in turizem močno prispevata k svetovnim emisijam toplogrednih plinov, hkrati pa nanju vplivajo podnebne spremembe. Tretji del 2. poglavja torej ponuja uvod v raziskave okoljske trajnosti na tem področju, s poudarkom na empiričnih raziskavah, ki so pomembne za to disertacijo. Nazadnje predstavim še obsežen pregled literature o izbranem okolju prijaznem vedenju v turizmu – prostovoljni izravnavi ogljika.

Empirični del disertacije sestavlja spletni eksperiment o tem, kako pri odločitvah o prostovoljni izravnavi ogljika okvirjanje izgube vpliva na dejansko vedenje. V randomiziranem kontrolnem eksperimentu sem trem skupinam udeležencem predstavila nekoliko različne opise prostovoljne izravnave ogljika. Po izpolnitvi naloge, s katero so udeleženci lahko zaslužili denar za nakup prostovoljne izravnave ogljika – kar je novost v raziskavah okolju prijaznega vedenja v turizmu –, so se udeleženci lahko odločili, ali bodo zaslužek namenili eni od organizacij za prostovoljno izravnavo ogljika ali pa ga bodo obdržali. Tej odločitvi, ki je imela dejanske posledice in je bila tako združljiva s spodbudami (*angl.* incentive-compatible), so sledila vprašanja o stališčih o prostovoljni izravnavi ogljika. Z namenom zmanjšanja pristranskosti skupne metode so bila vprašanja o teh stališčih pri polovici udeležencev eksperimenta postavljena pred odločitvijo, komu nameniti zaslužek iz naslova naloge. Sledil je vprašalnik z vprašanji o psihografiji, navadah in sociodemografiji udeležencev. Za boljšo pripravo na poskus je bil izveden predtest, osnovan na pristopu mešanih metod, vključno s fokusno skupino, anketo za preverjanje ustreznosti posameznikov za sodelovanje in dvema krogoma pilotnih poskusov.

Rezultati razkrivajo, da okvirjanje izgube ni imelo tako močnega učinka kot v predhodnih študijah. Ena možna razlaga za to je strošek povezan z okolju prijazno odločitvijo v tem eksperimentu, katerega v drugih študijah ni bilo. Okvirjanje izgube je imelo s teorijo podprt statistično značilen učinek na vedenje prostovoljne izravnave ogljika v enem vrstnem redu ankete: udeleženci, ki so prebrali sporočilo z okvirjeno izgubo, so bili bolj dovzetni za nakup prostovoljne izravnave ogljika kot udeleženci, ki so prebrali sporočilo z okvirjeno koristjo ali sporočilo brez okvira (kontrolna skupina). Omenjenega učinka okvirjanja izgube ni bilo pri nasprotnem anketnem vrstnem redu, v katerem so bila vprašanja o stališčih postavljena pred izvedbo naloge in odločitvijo o razporeditvi zaslužka. Eno razlago za to lahko najdemo v teoriji dvojnega procesiranja: okvirjanje izgube je delovalo le kot dregljaj, ki izvira iz Sistema 1, tj. dregljaj, ki cilja na podzavestne in samodejne procese odločanja. Po drugi strani pa je zaradi prej postavljenih vprašanj o stališčih pri drugem vrstnem redu ankete odločitev, komu nameniti zaslužek, postala bolj refleksivna, zaradi česar je oblikovanje izgube kot dregljaj izgubilo svoj učinek.

Druga pomembna ugotovitev eksperimenta je, da obstaja oprijemljiva vrzel med nameni in vedenjem. Ta rezultat lahko služi kot opozorilo raziskovalcem, da se ne zanašajo na meritve vedenjske namere kot indikatorja dejanskega vedenja. Rezultati prav tako kažejo na vrzel med stališčem do prostovoljne izravnave ogljika in vedenjem: ne samo da pozitiven odnos ni bil vedno povezan z vedenjem, ampak je pri številnih udeležencih negativno stališče *bilo* povezano z vedenjem, tj. z odločitvijo za izravnavo ogljika. To nakazuje, da pozitivno stališče ni predpogoj za okolju prijazno vedenje, ugotovitev, ki je v nasprotju z implicitnimi predpostavkami v literaturi, ki se opirajo na teorijo načrtovanega vedenja (*angl.* theory of planned behaviour).

Diskusija, ki sledi, podaja teoretično razlago rezultatov hipotez in navaja metodološke, praktične ter teoretične prispevke disertacije. Poleg prednosti in dodane vrednosti, že predstavljenih v tem povzetku, prispeva disertacija tudi nekaj uporabnih idej za

implementacijo dregljajev v praksi. Oblikovalcem politik predlagam, da v svojih okoljskih pozivih k okolju prijaznem vedenju uporabijo okvir izgube – to je, da poudarijo negativne posledice neizvedbe želenega vedenja za okolje. Ta spodbuda je lahko še posebej učinkovita, če je nameščena neposredno (začasno in/ali fizično) ob zadevnem vedenju in v kombinaciji z drugimi intervencijami, kot so finančne spodbude. Navsezadnje se moramo pri tako kompleksnem izzivu, kot je okoljska trajnost, nasloniti na kombinacijo različnih pristopov in ukrepov, da bodo kar najbolje delovali.

Ključne besede: nenaklonjenost izgubi, okvirjanje izgube, vrzel med stališčem in vedenjem, okolju prijazno vedenje, trajnostni turizem.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

CO_2	Carbon dioxide
EU	European Union
$GtCO_2e$	Gigatonnes of carbon dioxide-equivalent
ICAO	International Civil Aviation Organization
RCT	Randomised controlled trial
UNEP	United Nations Environment Programme
UNWTO	United Nations World Tourism Organisation
VCO	Voluntary carbon offsetting *(only used in survey text)*
VIF	Variance inflation factor

WTA	Willingness to accept
WTP	Willingness to pay
WTTC	World Travel and Tourism Council

GLOSSARY OF KEY TERMS

Attitude The dictionary defines attitude as the "mental position with regard to a fact or state" or "a feeling or emotion toward a fact or state" (Merriam-Webster, n.d.a). Academic literature is no more concrete: Allport (1935) put forward 16 definitions of attitude. Referring to the multitude of definitions and interpretations of the term, Passafaro (2020) asserts that rather than describing a single unique phenomenon, attitude refers to a 'family' of closely related concepts. When we talk about behaviour-specific attitudes, we can lean on Ajzen's (1991, p. 188) definition: "the degree to which a person has a favourable or unfavourable evaluation of a specific behaviour".

Behaviour By definition, behaviour refers to (i) "the manner of conducting" (Merriam-Webster, n.d.b. – here cited example includes 'criminal *behaviour'*) or (ii) "anything that an organism does involving action", "the response of an individual […] to its environment" (ibid.). Behaviour refers to genuine action or conduct; other decisions that do not involve an action that is observed by the researcher are referred to as stated preferences or self-report measures. This thesis concerns itself with the behaviour of individuals (rather than firms or policy).

Framing For consistency and clarity, this thesis uses the term 'framing' only for the framing in focus, that is goal valence framing. This type of framing presents the same information but highlights either the negative or the positive outcomes of some action (Levin et al., 1998). Where relevant, I shall refer to the two subtypes of goal valence framing – gain and loss framing – separately. Other uses of the word framing in social sciences research will be replaced by an appropriate synonym to avoid confusion.

Intention Intention is the "determination to act in a certain way" (Merriam-Webster, n.d.c). In the academic literature, behavioural intention has been defined as "instructions that people give to themselves to behave in certain ways" (Triandis, 1980, p. 203).

Pro-environmental behaviour This dissertation uses both meanings of behaviour (see above): the former to designate and or categorise behaviour type (e.g. pro-environmental behaviour, recycling behaviour etc.), and the latter to distinguish methodologically between genuine action and preferences surrounding that

behaviour.

Pro-environmental behaviour can be defined as "behaviour that consciously seeks to minimize the negative impact of one's actions on the natural and built world" (Kollmuss and Agyeman, 2002, p. 240). Two things must be noted from this definition. First, the decision-maker is the individual ("one's actions"), representing the consumer perspective, rather than business or nation-state. Pro-environmental behaviour therefore does not include corporate social responsibility or circular economy, nor does it include policy that is not directed at the individual. Second, the authors refer exclusively to deliberate behaviour, a stance which this thesis departs from. In line with the behavioural economic school of thought, decisions can be either slow and deliberate, or fast, intuitive and subconscious (Kahneman, 2011). One's actions can thus positively impact the environment (or minimise the negative impact) subconsciously, either as a result of own habit or unnoticed choice architecture (see chapter 2.1.5).

For consistency, this thesis will primarily employ the term *pro-environmental* behaviour. An exception to this are 'green nudges' (rather than pro-environmental nudges), which is how they have been defined and used in the behavioural environmental economic literature (Schubert, 2017; Sunstein et al., 2019).

Pro-environmental decisions

To separate behaviour from stated preferences, this thesis uses the term 'pro-environmental *decisions',* under which fall both genuine behaviour (action) and expressed preferences surrounding that behaviour. This thesis adopts the term in methodological contexts to improve transparency over which study outcome variables (own or employed elsewhere) are used. The term is used to emphasise the important distinction between behaviour and stated preferences.

Stated preferences

In the widest sense, preferences reflect a person's stance towards any action or its outcome, whether market-based or not. For the purpose of this thesis, stated preferences are the overarching construct that captures an individual's expressed attitudes towards an action or its consequence, his or her willingness to carry the action out (both as a dichotomous construct and in levels), and the expressed intention or plan to do so. These outcome variables are sometimes also referred to as 'self-report measures' (Lange, 2022). Stated preferences contrast with revealed preferences, which represent the actual consumption decisions taken by an individual, regardless of whether they are verbally expressed or not (Samuelson, 1938).

Tourism	The Tourism Satellite Account, developed jointly by the OECD, UNWTO and Eurostat, defines tourism as the "activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited" (OECD, n.d.). It includes both the travel of visitors to their destination and activity of visitors at their destination (UNWTO, 2010). Travel for the purpose of tourism is considered a subset of travel.
Travel	The movement between different geographic locations for any purpose and any duration. Travel is considered a touristic activity (UNWTO, 2010).

1 INTRODUCTION

1.1 Motivation for research

Environmental sustainability is one of the defining challenges of our era. In 2021 and 2022, the Intergovernmental Panel on Climate Change released its most alarming reports yet, prompting the United National Secretary-General António Guterres to declare a "code red for humanity" (United Nations, 2021). 11,000 scientists from over 160 countries and more than 2,000 national and sub-national jurisdictions declared a climate emergency (Climate Emergency Declaration, 2021; Ripple et al., 2019). This follows from witnessing high concentrations of carbon dioxide and other greenhouse gasses in the atmosphere at levels that are unprecedented in the records (Intergovernmental Panel on Climate Change, 2021) and double that which can be absorbed (NOAA, 2022). Shifting climate conditions are a threat to environmental (and social and economic) sustainability: they endanger eco-systems, biodiversity, food sources, water and other natural resources, as well as our health, physical safety and economic security.

In order to mitigate human's negative impact on the environment, we need action from all stakeholders: policy makers to design and implement necessary measures; the scientific community to develop pro-environmental solutions and technology; businesses to change their production practices; and us, individuals, to change our behaviour. This dissertation focuses on individuals as independent decision-makers and how our behaviour may be influenced by private or public sector stakeholders. The subject of this thesis is thus pro-environmental behaviour. Since both real behaviour and stated preferences surrounding that behaviour are investigated, the titular term pro-environmental *decisions* is used to distinguish between the two and to emphasise the importance of doing so.

Traditional economic models assume people have rational preferences over outcomes and make decisions that yield optimal results given constraints; decision-making can be improved simply by increasing the number of choices, changing their attractiveness or providing more information (Frederiks et al., 2015). Policy makers – either implicitly or explicitly – rely on these assumptions of the rational decision-maker (Dolan et al., 2012). They implement bans or regulations that change the choices available; they provide subsidies or introduce taxation that change the incentive structure; and they launch information and education campaigns with the aim of increasing knowledge about these choices.

Yet – as a growing body of research in behavioural economics demonstrates – individuals do not make decisions rationally: their behaviour is often based on heuristic decision making, which systematically deviates from traditional economic assumptions (Tversky and Kahneman, 1974). This thesis takes the vantage point of behavioural environmental economics and examines the effect of one particular bias on pro-environmental behaviour.

1.2 Research topic and theoretical background

Behavioural economics developed as a critique of neoclassical models of economic thought that were based on expected utility theory (Von Neumann and Morgenstern, 1944). The studies first conducted consisted of basic research, often experimental, which sought to identify and explain cognitive biases in decision making (e.g. Tversky and Kahneman, 1974). Applied research followed in the 21st century, boosted by the publication of Nudge (Thaler and Sunstein, 2009). Applied to public policy, the main proposition is that people do not only respond to information and incentives, but also to how these are framed and communicated (ibid.). As Dolan et al. (2012) argue, policy that leans on tools such as information and incentives leads to high variance in behaviour that cannot be explained.

One bias that can be addressed or leveraged for policy goals – and the main construct of this thesis – is loss aversion. The loss aversion hypothesis postulates that the gains and losses that individuals experience relative to a reference point are asymmetric, with the pain of losses stronger than the enjoyment of gains (Kahneman and Tversky, 1979).

The theoretical framework of loss aversion is established in prospect theory. Its two other main features are reference dependence (meaning that gains and losses are defined relative to a reference point) and diminishing sensitivity (marginal value of losses and gains decrease with size) (Kahneman and Tversky, 1979). As it was conceived, loss aversion described a phenomenon observed when individuals faced monetary gambles, i.e. monetary decisions under risk. It was later extended to riskless choices and non-monetary decisions about private outcomes (Thaler, 1980). Decisions about actions towards the environment are particularly interesting because they oftentimes involve weighing immediate individual costs (monetary, effort or otherwise) against collective non-monetary benefits in the future.

When working with loss aversion, it is also important to understand two related theories: dual process theory and nudge theory. The former was developed by cognitive psychologists to describe the premise that an individual's mental processes can be divided into two distinct types: the fast and intuitive, and the slow and deliberate (Stanovich and West, 2000). The theory is useful for understanding why loss aversion occurs and how this affects the policy interventions that aim to rectify or leverage it. Policy interventions can also be informed by nudge theory, which postulates that individual behaviour can be influenced by subtle changes to the decision environment (Thaler and Sunstein, 2009).

An examination into loss aversion requires employing an applied extension. Three have been identified in the literature: default bias, endowment effect and loss framing. This thesis will examine loss aversion through loss framing. Loss framing of a message emphasises the losses resulting from an undesirable action or from the absence of a desirable action, thereby guiding people with loss aversion tendencies to a particular choice (Avineri and Owen, 2013). It falls under the wider category of valence framing, which semantically restructures a message so that it is presented in either a positive or negative light (Levin et al., 1998), and more concretely, valence goal framing, which characterises (the same) information depending on whether it emphasises the potential gain or loss resulting from a certain action (ibid.).

Persuaders can use different goal frames to encourage the same outcome, and as such they can not only test, but also manipulate the loss aversion bias to fit their purpose.

In the environmental context, the loss aversion hypothesis would suggest that messages that frame the environmental consequence from an action as a loss to be avoided (rather than gain to be achieved) will increase the likelihood of pro-environmental behaviour.

I also make a clear distinction between stated preferences and actual behaviour. The latter involves observable activity or action; the former includes different manifestations of self-reported preference, namely attitudes, behavioural intentions and willingness to pay. The reason for this distinction is fourfold: firstly, awareness of being in a research setting means stated preferences are necessarily conscious; the absence of this awareness in experiments measuring behaviour allows for automatic and subconscious decision-making. The difference in the characteristics of the cognitive process involved may result in different (susceptibility to) biases (Evans, 2019). Preferences may further be constructed in the mere process of making a decision (Payne et al., 1992), thus not reflecting 'true' preferences. Third, people may be poor observers of their own behaviour and likely susceptible to reporting biases and memory gaps (Gifford, 2014). Finally, evidence collected so far suggests that faced with environmental decisions, people exhibit hypothetical bias – a discrepancy between attitudes, intentions or willingness to pay, on the one hand, and behaviour, on the other (Kollmuss and Agyeman, 2002; Seip and Strand, 1992). This gap reinforces the proposition that stated and revealed preferences are not influenced by the same underlying process.

1.3 Research context in focus

This dissertation pays special attention to travel and tourism. The scale of the tourism industry's contribution to climate change makes it particularly important for researching pro-environmental behaviour: it accounts for approximately 8% of global greenhouse gas emissions, of which 20% can be attributed to air travel (Lenzen et al., 2018). According to other calculations, air travel contributes between 2 and 3.5% of total global greenhouse gas emissions (Lee et al., 2021; UNWTO-ITF, 2019). A reduction of the high emissions from air travel in line with climate targets may be difficult through marginal policy changes and technology improvements alone, calling for individual action.

The pro-environmental behaviour in focus is the purchase of voluntary carbon offsets for air travel. The motivation for this is threefold. Since foregoing a flight represents a substantial cost to the global economy and a personal sacrifice, voluntary carbon offsetting could be the next-best thing. Yet, take-up is currently low. This represents a challenge as well as an opportunity. Methodologically, the strength of this type of pro-environmental behaviour is that it can be measured directly online, mimicking real world decision-making. Finally, for theory, there is a wide range of different reasons for low take-up proposed in the literature, yet very few studies lean on behavioural economic insights.

Since I am conducting a real-behaviour experiment, focus on one type of environmentally sustainable behaviour within travel and tourism was necessary. Though the behaviour in focus is voluntary carbon offsetting, the comprehensive examination of the literature (including a

stand-alone systematic literature review) covers loss aversion and pro-environmental behaviour more generally. My hope is also for the empirical study to provide useful insights that can be extrapolated to other types of pro-environmental behaviour and settings.

1.4 Research purpose and objectives

The purpose of this doctoral dissertation is to contribute to mitigating the negative impact of individuals on the environment.

The research goal is to examine the effect of loss aversion – concretely, through loss framing – on pro-environmental decisions, and whether it can be used to inform the design of public policy and add value to the pool of knowledge. By analogy, my overarching research question is: *"Does loss aversion have an effect on pro-environmental decisions?"*

My research objectives are the following:

- to understand how loss aversion relates to pro-environmental behaviour,
- to gather existing evidence on the effect of loss and gain framing on pro-environmental decisions,
- to analyse and organise this evidence in order to define the conditions under which loss and gain framing work to achieve pro-environmental behaviour,
- to experimentally test the effect of loss and gain framing on pro-environmental decisions in an incentive-compatible online environment,
- in the same experimental setting, to establish whether there exist gaps between pro-environmental attitudes and behaviour, or intentions and behaviour,
- to draw from the literature and bring together different theoretical explanations for the experiment results, and
- to put forward policy suggestions based on the experiment and from the findings of others (gathered in the literature review).

1.5 Methodological approach

In order to achieve my research objectives, goal and purpose, a thorough understanding of the construct of the thesis (loss aversion) was first needed, as well as how it interacts with the subject (pro-environmental behaviour), and the context it is empirically investigated in (tourism and voluntary carbon offsetting). This constitutes the theoretical component of my thesis and consists of:

- a theoretical exploration of the foundation for loss aversion when making pro-environmental decisions,
- a systematic literature review of loss framing on pro-environmental decisions,
- a focused review of environmental sustainability in tourism research as it pertains to this thesis, and

- a scoping and literature review of voluntary carbon offsetting.

The empirical component of the thesis includes a real-behaviour online experiment, together with a mixed-method pre-test.

The rationale for running the experiment online lies in the possibility to measure attitudes, behavioural intentions and behaviour within the same setting, in its replicability, and in its ability to quickly recruit large heterogeneous samples of the population (Birnbaum, 2004). Observed empirical discrepancies between the three outcome variables necessitate that we measure all of them, ideally simultaneously, yet due to methodological constraints very few studies do so. Surveys and choice experiments, employed most often, can paint a detailed picture of an individual's preferences and economic valuation of environmental goods but cannot detect actual behaviour and are thus vulnerable to hypothetical bias (Beck et al., 2016). Field experiments, by contrast, allow the measurement of behaviour and enjoy high external validity, but risk external confounding and allow for only limited knowledge on the participants. Finally, traditional laboratory experiments allow for a less diverse subject pool and a more artificial setting than online experiments (Grootswagers, 2020).

This study was conducted as a randomised controlled trial, in which participants were equally divided into two treatment groups and a control. I included a real effort task with actual income – a common feature in experimental economics but not yet applied to tourism research – to mimic real world decision-making. The real behaviour component of the study was the decision on whether to use earnings from the task to purchase a voluntary carbon offset.

In order to ensure the experiment and survey were understood as intended, three pre-tests were run. The qualitative pre-test consisted of a focus group, in which the participants' opinions of- and experiences with voluntary carbon offsetting were discussed. The focus group protocol also consisted of a manipulation check to confirm correct interpretation of the loss- and gain-framings of the voluntary carbon offsetting description. The quantitative phase of the pre-test comprised a screening survey and pilot tests. The aim of the screening survey was to filter-in individuals that are eligible for the study and its pilots. Two rounds of pilot tests were then run, through which I wanted to verify the intended frame manipulation and test the reliability of the constructs.

For analysis, I first conducted simple cross-tabulation with a chi-square statistical test to define the offsetter profiles. Through this, I was able to establish which individual characteristics (socio-demographic groups, habits, value orientation, beliefs and so on) were associated with a positive attitude towards voluntary carbon offsetting and with a higher likelihood of purchasing an offset within the study. To test my hypotheses, I then ran a linear regression of treatment effects on attitudes, and a binary logistic regression of treatment effects on behaviour. Gaps between attitudes and behaviour, and intention and behaviour were quantified with statistical tests of proportion. A number of other statistical techniques were also employed in the data preparation and validation stages, and for inspection of hypothesis results.

1.6 Structure of the dissertation

This doctoral dissertation is in the form of a monograph with a theoretical and empirical component, introduced through a general introduction and rounded off with a conclusion.

The theoretical section involves a theory and literature review. I start with the dissertation's main construct of loss aversion, first introducing its theoretical foundation of prospect theory (which was developed separate from environmental decision-making) as well as other pertinent theories, before bringing it together with my research subject of pro-environmental behaviour. I then provide a systematic literature review of the effect of loss framing – the chosen application of loss aversion – on pro-environmental decisions. This chapter was published as the following article in the journal Ecological Economics: *Homar, A. R., & Cvelbar, L. K. (2021). The effects of framing on environmental decisions: A systematic literature review. Ecological Economics, 183, 106950.*

Chapter 2 continues with a bird's-eye view of environmental sustainability in tourism, the economic industry and socio-political system the behaviour in focus – voluntary carbon offsetting for air travel – can be found in. The focus in this section is on the latest research trends as relevant to the topic of this dissertation, and on the experimental studies conducted. The final chapter of the literature review presents voluntary carbon offsets. Here, I sought to provide a comprehensive review of the concept and related literature, methodically organising the latter according to the determinants of take-up identified in the literature.

The main empirical component of the thesis is an online experiment on the effect of framing on the purchase of voluntary carbon offsets. A detailed methodology, paying due attention to potential risks and how they were mitigated, is provided in chapter 3. This chapter also includes the results and implications of the three rounds of pre-tests.

Chapter 4 presents the experiment results. The first section records the sample characteristics and the main descriptive results of the experiment. Section 4.2 describes the profiles of offsetters – which socio-demographic and psychographic groups of people were statistically more likely to offset within the experiment. The final section presents the results of hypothesis testing.

Chapter 5 presents a discussion of the experiment findings: how the hypothesis results can be interpreted, and how they relate to theory and conclusions reached elsewhere. Section 5.2 explains how these findings and the accompanying discussion contribute to theory, practice and research methods. I also acknowledge the theoretical, practical and methodological limitations of the thesis, before concluding the chapter with suggestions for further research.

The final chapter represents the conclusion to this thesis.

2 LITERATURE AND THEORY REVIEW

2.1 Behavioural economics and the environment

This chapter provides a brief overview of behavioural environmental economics, the discipline that gave birth to loss aversion and the corresponding framing interventions to encourage pro-environmental behaviour.

Behavioural economics is an academic discipline that lies at the intersection of economics and psychology, and studies the effects of psychological, cognitive, emotional, cultural and social factors on the economic decisions of individuals and institutions (Teitelbaum and Zeiler, 2018). It is particularly concerned with deviations in decision-making from those stipulated in neoclassical economics; it seeks to explore, catalogue and make sense of systematic discrepancies with rational choice theory (Shogren and Taylor, 2008).

The definition above captures the threefold rationale for the development of behavioural economics as a response to neoclassical economics. First, it claims that the assumptions of neoclassical economic theories do not hold. Mullainathan and Thaler (2000) propose three categories of limits on human behaviour: bounded rationality, bounded willpower and bounded self-interest. The first involves cognitive biases and other manifestations of inconsistent preferences. One of the earliest observations of these was made by Allais (1953), who developed a choice problem known as the Allais paradox as an example of a violation of the independence axiom of rationality. A feature of biases are also mental shortcuts (heuristics), reported soon after by Simon (1956), who suggested that people 'satisfice' when making decisions instead of choosing optimally. Bounded willpower comprises various impulses, visceral factors and limits to self-control, whilst bounded self-interest covers altruism, inequality aversion, concerns for reciprocity and fairness, and general other-regarding preferences. According to Simon (1956), bounded cognitive ability also represents a limitation to neoclassical economics. Adopting the language of Lakatos (1976), Pasche (2016) contends that it is only bounded rationality that belongs to the 'hard core' of neoclassical economics: rational choice theory and its sibling equally inherent to the economic discipline, expected utility theory. By contrast, whilst unbounded willpower and particularly self-interest of economic agents are common assumptions, they can be incorporated into the utility function, thus comprising the 'belt' of neoclassical economics. Although the behavioural economics discipline is indeed interested in more than cognitive biases, research in other-regarding preferences is often integrated into the utility (maximising) function, rather than seeking to invalidate it (e.g. Fehr and Schmidt, 1999).

Second, the biases in human judgment are systematic. Neoclassical economic models and theories assume human errors are randomly distributed with mean zero, thereby averaging out in aggregate, leaving predictions unbiased on average. Yet, decision-making has been shown to be systematically biased and errors predictable, resulting in deviations that do not average out (e.g. Kahneman and Tversky, 1973). Third, related to the observation that biases are systematic, they are also found to be strong: they do not only exist in the tails of the

distribution, but result in nontrivial deviations from economic efficiency (Thaler, 2016). This leads to an important weakening of the predictive and explanatory power of traditional economic models.

I start the chapter by providing an overview of the three theories used in behavioural economics that are of relevance for this thesis. It must be emphasised that behavioural economics is at its core a convolution of empirical findings on heuristics and biases in decision-making. This is to say, theories recounted here are not developed *within* the behavioural economic discipline to resolve cognitive biases, but brought in to help explain these biases on an *ad-hoc* basis. The bias that the theories recounted here seek to explain is loss aversion, the main construct of interest in this thesis. Loss aversion originated in prospect theory (section 2.1.1) and has been explained through dual process theory (2.1.2). Their practical extension and foundation of loss framing is nudge theory, which is presented in section 2.1.3. Section 2.1.4 brings in the environment: I evaluate pro-environmental behaviour from the vantage point of behavioural economics. I focus on the decision-maker of relevance to this study: the individual consumer, rather than farmer, firm or nation-state. Sections 2.1.5 and 2.1.6 provide a brief theoretical introduction to loss aversion as applied to pro-environmental behaviour. Moving from theory to practice, section 2.1.7 presents green nudges as an application of behavioural economic insights. Recognition of the 'competing' paradigm of rational choice, together with the theories it underlies – many of which have been used widely in the environmental literature – follows (2.1.8). The chapter concludes with an analysis of the gap between stated and revealed preferences, an important phenomenon that necessitates investigation for more effective policy and research.

2.1.1 Prospect theory

Amos Tversky and Daniel Kahneman's behavioural decision research on uncertainty and risk in the 1970s and 1980s represents what may be the first consistent framework for the observed violations of rationality in decision-making. The goal of their early body of work was to understand why individuals often make errors in probabilistic judgement. They found that individuals often resort to heuristics (mental shortcuts), which may be helpful or, instead, biased in how they undermine their analytic or reflective abilities (Tversky and Kahneman, 1974). Through several experiments, Tversky and Kahneman (1973; 1974) identified a number of biases in judgment people make when making decisions, the first of which were availability bias, the representativeness heuristic (the tendency to neglect the base rate in favour of stereotypes or other preconceived notions of the parent population), and anchoring (decisions influenced by a particular reference point or 'anchor'). They find that these biases are systematic in nature, leading to systematic (and not random) measurement error.

To explain the biases they observed in the laboratory, Kahneman and Tversky (1979) developed prospect theory. The theory stipulates that preferences are determined by attitudes to gains and losses, defined relative to a reference point. The theory has three components, listed below and illustrated in Figure 1:

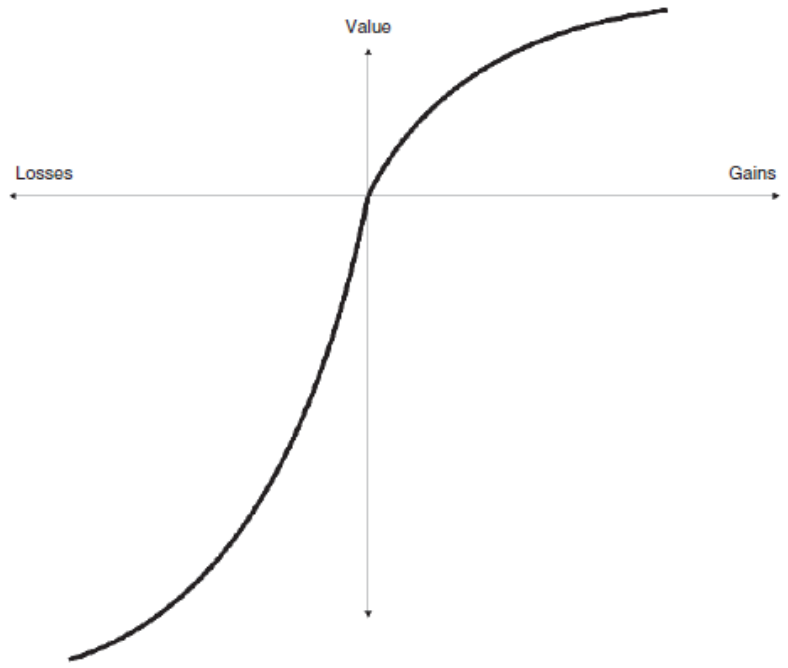
(i) The utility function is defined over gains and losses around a reference point, implying changes in a particular construct (e.g. income, wealth) are perceived as more important than the level of that construct.

(ii) Both the gain and the loss function display diminishing sensitivity: individuals are risk-averse in the gain domain (the function is concave) and risk-seeking in the domain of losses (the function is convex).

(iii) There is a kink at the reference point, indicating loss aversion.

As can be seen from its terminology, modelling framework and implicit assumption of utility maximisation, prospect theory is still very much rooted in the (wider) economic discipline. Indeed, part of its rationale is to form a critical response to neoclassical economic theory *using their language*. As Kahneman (2003, p. 1457) writes: "A theory of choice that completely ignores feelings such as the pain of losses and the regret of mistakes is not only descriptively unrealistic, it also leads to prescriptions that do not maximize the utility of outcomes as they are actually experienced - that is, utility as Bentham conceived it". Though this approach has attracted some criticism (e.g. Pasche, 2016), it allows for greater computational robustness, replicability and, therewith, explanatory power.

Figure 1: The value function according to prospect theory



Source: Kahneman and Tversky, 1979

Loss aversion

An inherent concept of prospect theory is loss aversion, the main construct of this thesis. Loss aversion refers to the tendency to avoid losses more than to seek gains of equal size (Kahneman et al., 1991). The theoretical reasoning for this outcome is that losses are, psychologically, twice as powerful as gains (Tversky and Kahneman, 1992). Loss aversion can also be seen as a manifestation of negativity bias in our attention, in which people are

psychologically more affected by negative than positive outcomes (Meyerowitz and Chaiken, 1987).

Loss aversion is the cornerstone of behavioural economics and behavioural finance. It has been developed for- and later mainly applied to decisions involving known financial payoffs. For instance, as part of prospect theory, it can help explain why some people may prefer to avoid a loss of €10 to winning €10 with equal probability. Loss aversion has implications for the endowment effect, status quo bias and framing.

One manifestation of loss aversion is the endowment effect. Though it was already Aristotle who observed the phenomenon of attaching greater value to one's own possessions (The Nicomachean Ethics, book IX - Peters, 1906), an 'endowment effect' can lead to greater valuation of one's own possession even without sentimental or other subjective value. The term refers to the tendency of individuals to demand more money to give up an object than they would be willing to pay to acquire it (Thaler, 1980). Indeed, there is an observed empirical gap between willingness to accept (WTA) and willingness to pay (WTP), even for objects that have just been acquired and have no other cause for attachment (Kahneman et al., 1990).

Status quo bias refers to the preference of the current state of affairs (Samuelson and Zeckhauser, 1988). It is related, but not equivalent, to default bias – the tendency to accept a preselected (default) option among a list of options (Johnson and Goldstein, 2003). The phenomenon has been most strongly related to fear from changes to the status quo resulting from loss aversion (Kahneman et al., 1990), but can also be a reflection of limited cognitive capacity to make a decision and optimisation of effort.

Framing effects can be considered another practical application of loss aversion: an individual may choose to avoid a price change framed as a €10 surcharge in place of one framed as a €10 discount. The former presents an avoidance of a loss; the latter a gain achieved.

Tversky and Kahneman considered many heuristics to be the result of differential mental processing, stipulated by dual process theory from cognitive psychology. In providing a review of his research on heuristics and biases with Amos Tversky, Kahneman (2011) leans on dual process theory, adopting Stanovich and West's (2000) terminology of 'System 1' and 'System 2'. This justification was, however, done in retrospect: "Although Amos and I were not working with the two-systems model of the mind, it's clear now that there are three cognitive features at the heart of prospect theory. They play an essential role in the evaluation of financial outcomes and are common to many automatic processes of perception, judgment, and emotion." (Kahneman, 2011, p. 273).

2.1.2 Dual process theory

Dual process theory seeks to explain the gap between human reasoning (such as attitudes) and actual decisions taken. There exists a constellation of dualistic decision models that fall under the framework of the dual process theory (Evans and Stanovich, 2013). For simplicity I use the singular, but the reader should be aware that this overarching theory has a number of

interpretations and variants, all resting on the assumption that mental processes fall under two types. The earliest is the dichotomy between heuristic processing and analytic processing (Evans, 1984), which Evans himself later renamed into Type 1 and Type 2 processes (Evans and Stanovich 2013). Epstein (1994) differentiates between the experiential system and the rational system, while Stanovich and West (2000) and Kahneman and Frederick (2002; 2005) simply refer to them as System 1 and System 2. Shefrin and Thaler (1988) define their dual preference structure as divided into a doer and planner, the former emotional and the latter the more rational aspect of personality.

Dual process decision models all seek to categorise mental processes into two types, of which I present a summary in Table 1. The first is intuitive, fast, effortless, subconscious, automatic, and independent of cognitive ability or working memory; the second is deliberate, slow and effortful (Evans, 2011; Kahneman, 2003; Stanovich and West, 2000). Dual process models do not exclude an interaction or overlap between the two systems of reasoning: the deliberate processes may endorse or override the proposed responses from the quick and intuitive processes, and both can act either concurrently or sequentially (Kahneman and Frederick, 2005).

Through most of this thesis[1], I follow Kahneman's (2011) terminology of System 1 and System 2, since he (together with Amos Tversky) articulated loss aversion as used here. As Kahneman (2011) himself emphasises, despite the connotation, the two systems are not mechanically demarcated, as critics argue (Grayot, 2020), but rather a useful way of description. They are substantively analogous to Type 1 and Type 2 cognitive processes of Evans and Stanovich (2013).

According to critics (e.g. Grayot, 2020), the dichotomy between system 2 as rational decision-making and system 1 as irrational or non-rational is not tenable. Notwithstanding, some researchers claim the processes may be reflected in different *types* of biases. According to Evans (2006), Type 1 processes may lead to fundamental heuristic bias, where people focus on information subconsciously or preconsciously cued as relevant. By contrast, bias resulting from Type 2 processes is analytic and deliberative, with examples including rationalisation and over-thinking. To be clear, neither type of reasoning necessarily lead to biases; both System 1 and System 2 cognitive processes can be accurate, effective and, indeed, optimal in a given situation.

Whether dual process models have a neuroscientific foundation is disputed. On the one hand, some studies suggest that System 1 cognitive processes stem from the amygdala, one of the evolutionarily oldest parts of the brain that takes care of immediate physical needs, and System 2 processes are associated with the newer parts of the brain, such as the prefrontal cortex (Menzel, 2013). Critics, however, contend that the evidence is scant and not enough to warrant attaching the two cognitive styles to a particular neural architecture (Grayot, 2020). It has also been argued that dual process theory takes a descriptive approach – seeking to describe our mental processes rather than explain their origins – thus becoming irrefutable and

[1] Where referring to an external proposition, I keep the term used by the author.

of limited use in practice (Pennycook, 2017). Dual process theory's descriptive nature may not be necessarily problematic (as Pennycook himself admits) since it can still be applied to problems and used to generate hypotheses. It is also useful as a tool to explain why some decisions (stemming from System 1) do not reflect preferences (an outcome of System 2 mental processes), and succeeds in improving behavioural economics' explanatory and predictive power vis-à-vis neoclassical economics, on the one hand, and other theories from environmental psychology, on the other (see sections 2.1.8 and 2.1.9).

Table 1: Distinction between System 1 and System 2 and their implications for behavioural economics

	System 1 / Type 1	**System 2 / Type 2**	***Source***
Characteristics	Fast	Slow	Kahneman (2003); Stanovich and West (2000)
	High capacity	Low capacity	
	Effortless	Effortful	
	Automatic	Deliberative	
	Associative	Rule-governed	
	Governed by habit	Controlled	
	Subconscious / unconscious	Conscious	Evans (2011)
Biases	Fundamental heuristic bias	Fundamental analytic bias	Evans (2006)
	Biases are universal	Biases depend on the individual's ability to override Type 1 responses	Stanovich and West (2000)
Interventions for change	System 1 nudges – e.g. defaults, information framing or presentation,	System 2 nudges – e.g. information provision, education	Dolan et al. (2012); Sunstein (2016)
	Nudges	Financial incentives, moral or biospheric appeals to change, provision of information etc.	Michalek et al. (2015)

Source: author's own

2.1.3 Nudge theory

Nudge is defined as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein, 2009, p. 6). Nudge theory stipulates that by changing the decision environment ("choice architecture" according to Thaler and Sunstein's terminology), we can influence individual behaviour and change the likelihood he or she chooses one option over another. As Michalek et al. (2015, p. 8) write, "By adjusting this architecture appropriately, nudges can shift human attention to a particular aspect of the choice and thus trigger corresponding heuristics and associations."

As the practical arm of behavioural economics, nudge theory, too, rests on the assumption that ordinary decisionmakers have differential processing abilities, in line with dual process theory. Nudges are aimed at changing behaviour to align with the individual's own preferences or, where social rather than individual welfare is concerned, by circumventing these preferences. Carlsson et al. (2021) make a distinction according to the rationale for nudging between pro-self nudges and pro-social nudges. The former involves behavioural solutions to behavioural problems of negative internalities, e.g. health care nudges; the latter

comprises behavioural solutions to conventional economic problems of negative externalities (ibid.). It is this second group that green nudges belong to. That said, in practice there may be an overlap between the two types of nudges: encouraging altruism, for instance, may be in its design a pro-social nudge, but also leads to benefits to the self, either through the "warm glow" of giving (Andreoni, 1990) or through a feedback loop in the form of tangible personal benefits from giving to a charity in the long term.

Nudging can be contrasted against other interventions to influence behaviour in the policy toolkit: those that restrict choice (mandatory regulations, command and control standards), as well as those that do not restrict choice but still assume that people consciously analyse their options and make a utility-maximising decision in line with their preferences. This category includes positive and negative economic incentives, and persuasion through information provision and educational campaigns. Other non-restrictive policy tools target Type 2 mental processes, whilst nudges are aimed at influencing Type 1 processes (Michalek et al., 2015). Sunstein (2016), by contrast, considers information provision a type of nudge, concretely a System 2 nudge. These are "educative and target or benefit from deliberative processing […] [they] are specifically designed to increase people's own powers of agency" (Sunstein, 2016, p. 123). Similarly, System 1 nudges target System 1 mental processing: they intend to change behaviour without increasing the individual's awareness or knowledge of the outcome, or indeed his attitude towards it. System 1 nudges include graphic warnings and other illustrations, default rules, order of choices presented, and framing of information presented (ibid.).

A distinction must be made between nudges on the one hand, and behaviourally-informed and behaviourally-tested policy initiatives, on the other: the latter is an umbrella term that includes the former as well as other findings form social psychology, as the work of United Kingdom's Behavioural Insights Team illustrates (Behavioural Insights Team, n.d.).

When deliberating around the suitability of nudges as the instrument to reach a policy goal, the key question is what nudges are being positioned against. Critics may argue that nudges are paternalistic, since they claim to know what individuals need (e.g. Saint-Paul, 2012; Goodwin, 2012), but this argument only holds when comparing nudges to information campaigns and other 'soft' instruments. They are, in effect, much *less* paternalistic than regulations and laws, which also make up the policy toolkit. It is also worth noting that some choice architecture is always present, making paternalism impossible to avoid (Sunstein and Reisch, 2013).

Finally, researchers have proposed different criteria that lead to greater effectiveness of nudges: weak personal preferences regarding the outcome (Johnson and Goldstein, 2003); times of lower mental capacity, such as simultaneous tasks or time constraints (Schubert, 2017); attention devoted to the nudge (Le Grand and New, 2020); and time frame of behavioural change required (Michalek et al., 2015). Finally, maximising one's own utility, pro-self nudges may be more effective than pro-social nudges, which rely on a non-utility maximising individual, which violates the main axiom of economic theory. This leaves green nudges in somewhat of a predicament.

2.1.4 Behavioural economics and pro-environmental behaviour

Economic research has long excluded pro-environmental behaviour. At the same time, environmental economics rested on rational choice theory, but as Shogren (2012: 349) argues, "Assuming rational behavior for environmental policy is problematic when nature's goods and services lack the active market-like arbitrage needed to encourage consistent choice." With environmental economics resting on neoclassical economic assumptions of rationality, and behavioural economics not particularly concerned with the environment, there resulted a gap between environmental and behavioural economics (Shogren and Taylor, 2008). Knetsch argued for more interaction between the two more than two decades ago: "in view of the evidence, the seemingly quite deliberate avoidance of any accounting of these [behavioural] findings in the design of environmental policy or in debates over environmental values, does not appear to be the most productive means to improvement" (Knetsch, 1997, p. 209). Yet it is only recently that the sub-discipline of behavioural environmental economics has emerged, with a lot of potential for the use of behavioural insights for environmental purposes still untapped (Byerly et al., 2018). The discipline now includes on the theoretical side studies on how dual process theory and individual cognitive biases can explain pro-environmental decision-making; and practically, how interventions based on these insights – i.e. nudges – can be used as an environmental policy instrument. Other areas of interest to behavioural environmental economists, though not related to this thesis, include behavioural game theory for environmental conflict and cooperation (such as climate change negotiation), choices under risk, mechanism design for market failure, and non-market valuation (Shogren and Taylor, 2008).

Before proceeding, it must be noted that it would be wrong to claim an individual's level of environmental concern is here not important for behaviour. Instead, the topics in focus lay elsewhere – what, *in addition to preferences and utility*[2], shapes pro-environmental action.

Below I address four research questions of interest. First, supposing preferences influence reflective (System 2) decisions, which factors influence the automatic (System 1) behaviour (heading i)? Second, what drives which type of cognitive process is activated (ii)? Third, methodologically, how can we determine which System was activated for some specific behaviour (iii)? Finally, on the practical side, how can we use this knowledge to encourage pro-environmental behaviour (section 2.1.5)?

(i) Determinants of System 1 behaviour

It is important to reiterate that behavioural economics – and, by extension, behavioural environmental economics – was born out of a critique of neoclassical economic thought. It is a collection of empirical findings on biases in reasoning that contradict individual predictions of the rational choice paradigm which neoclassical economics (as well as a number of theories in psychology; see section 2.1.8) is based on. As such, findings on heuristics and biases must also be read and considered *in conjunction with* rational choice theories of behaviour.

[2] Since the behavioural economic discipline was born out of a critique of neoclassical economics (rather than psychology or other social sciences), this is the terminology often used.

According to some behavioural economists, System 1 decision-making is affected by heuristics and biases (Kahneman, 2011). This is not to say System 1 is characterised entirely by errors in judgement; automatic processes may be optimal for a given situation, but are prone to some cognitive biases that the more reflective System 2 is not. Some examples of biases that may affect environmentally-relevant decision-making include:

- *Loss aversion* (see below): the phenomenon whereby environmental losses are perceived as more severe than commensurate environmental gains occurring with equal probability. One approach to quantifying this is by calculating the gap between willingness to pay (for an environmental good) and willingness to accept (payment for that same good). The latter is estimated to exceed the former by a factor of about 2 on average, which can be attributed to loss aversion (e.g. Knetsch and Sinden, 1984; Kahneman et al., 1990). For environmental goods in particular, the gap is even larger, ranging from 2 to more than 10 (Cummings et al., 1986).

- *Sunk-cost fallacy:* the tendency to continue some course of action even when it becomes apparent that it will lead to suboptimal outcomes relative to an alternative, purely because we've already invested time and money in it. The bias helps explain, for instance, why fossil fuels remain the primary source of energy despite increasing evidence that renewable energy sources are more environmentally and economically sustainable (King, 2019).

- *Hyperbolic discounting*: the *over*-discounting of the future relative to the present; a stronger preference for immediate payoffs over better outcomes in the more distant future, going against one's future-self and reducing lifetime utility (Ainslie and Haendel, 1983). This bias may hinder our ability to take action to address climate change, a complex but distant[3] phenomenon.

- *Confirmation bias:* the tendency to seek, interpret, focus on, memorise and favour information that confirms one's previous convictions (Wason, 1960). For pro-environmental behaviour that is inconvenient in a given situation, confirmation bias may help individuals overcome any cognitive dissonance that would otherwise encourage them to act pro-environmentally.

(ii) Determinants of System 1 and System 2 activation

It is clear that some environmentally-relevant decisions are reflective and others are automatic. This differs both across individuals and across contexts. The question that arises, then, is what determines whether the individual (re)acts automatically and on intuition, or whether he or she pauses and deliberates on his/her decision.

According to Kahneman (2011, pp. 24-25), System 2 is activated "when it detects an error about to be made" and "when System 1 runs into difficulty". He continues (p.25):

[3] This is not to say that climate change effects cannot be observed already across the globe.

> "*The division of labor between System 1 and System 2 is highly efficient: it minimizes effort and optimizes performance. The arrangement works well most of the time because System 1 is generally very good at what it does: its models of familiar situations are accurate, its short-term predictions are usually accurate as well, and its initial reactions to challenges are swift and generally appropriate. System 1 has biases, however, systematic errors that it is prone to make in specified circumstances."*

Kahneman (2011, p. 28) also emphasises that it is not efficient to always resort to System 2 and question one's own routine decisions; "System 2 is much too slow and inefficient to serve as a substitute for System 1", he writes.

This all implies that whether it is System 1 or System 2 that is activated for a specific decision follows from some internal mechanism. What, precisely, influences this activation of either System is not clear. It seems puzzling, for instance, how System 2 can be activated "when it detects an error" (as above) if it needs to be active to detect an error in the first place. One tangible determinant offered in Kahneman's (2011) book is experience. He provides the example of driving: an experienced driver's driving decisions are rooted in System 1, while someone still learning may resort to the more deliberative System 2. Mental activities become automatic through prolonged practice. They can also become automatic through repeated execution, at which point they turn into habit. In other words, an activity that is done consciously from within System 2 can become subconscious and automatic if repeated often enough in a stable context. This has important implications for pro-environmental behaviour, which is overwhelmingly governed by habit (Darnton et al., 2011).

One idea implicit in applied behavioural economics research is that situational cues can trigger System 2 thinking when desired. If some action is habitual or assumed likely to be automatic, designing a disruption can stop System 1 in its tracks. Situational cues can similarly be manipulated without triggering System 2: they can transform habits within System 1. Such disruptions can be caused by nudges, which are elaborated on in section 2.1.5.

(iii) Methodological insights

An area of research that has been attracting increasing attention is using response times to identify the underlying cognitive process type when individuals make pro-social decisions. This method for connecting cognitive style with decisions originated in Rubinstein (2007; 2013), who postulated that faster decisions are more likely to be the outcome of intuitive, automatic processes, whilst slower decisions are more likely to be deliberative and involve a reflection of the consequences of a given choice. To my knowledge, only one study tests the relationship between response time and pro-environmental decision-making specifically. Lohse et al. (2016) experimentally test its relationship with the decision to contribute to an environmental public good, finding that contributors take 40% longer to make their decision, i.e. select whether to collect some monetary payoff or allocate it to climate change mitigation. This suggests the decision-making of contributors is more conscious and deliberate.

Findings for response time effects on pro-social decisions more generally are inconclusive. In Rand et al.'s (2012, 2014) experiments, contributions to a public good were higher when participants were under time pressure, though this this was not corroborated by Tinghog et al. (2013) or Verkoeijen and Bouwmeester (2014). On the other hand, Piovesan and Wengstrom (2009) find that subjects in dictator games are more generous when given time to reflect. However, inasmuch as this game requires strategic thinking since one's own payoff depends on the actions and payoffs of others, its findings may be less applicable to financial contributions to environmental goods.

More rigorous methods for identifying the cognitive foundations of behaviour belong to the neuroeconomic discipline. Scholars have sought to identify brain activity when making different economic decisions using techniques such as functional magnetic resonance imaging, positron emission tomography and others. A thorough review of this discipline would go beyond the scope of the present study; I would refer the interested reader to Loewenstein et al. (2008) and Konovalov and Krajbich (2016) for a more recent review.

2.1.5 Loss aversion in the environmental domain

As mentioned in section 2.1.1, loss aversion was initially conceived for decision making between monetary gambles, such as the choice between winning €10 and avoiding a loss of €10 with equal probability. The goods and outcomes under investigation were thus private and monetary. In this context, loss aversion has been empirically tested again and again and successfully replicated (Camerer, 2003; Ruggeri et al., 2020). The question here is whether loss aversion also occurs for environmental goods.

A key novelty of the environmental context is that when it comes to a number of green behaviour types and settings, we are dealing with a non-monetary and public good: decision-making involves weighing the individual costs against (potential) collective benefits. Whilst the consequences may be individual (e.g. locally concentrated water pollution from a nearby factory), monetary (e.g. damages from a hurricane borne by the state) or both (savings on utility bills), the good is by nature a non-monetary and public good. For clarity, the environmental good is not itself monetary but it can be assigned a monetary value. Further, while the final outcome is non-monetary – greenhouse gas emissions, water scarcity and air pollution – the action can be. A commonly researched topic by environmental economists, for instance, is the valuation of public goods and resources, often measured through willingness to pay (Sagoff, 2011; Veronesi et al., 2014), or, less frequently, financial contributions to a public good, measured through actual payments (Michaud et al., 2013). If the thought processes surrounding the behaviour is indeed different for public and non-monetary goods such as the environment, the potential for leveraging loss aversion for behavioural change may diminish.

The non-pecuniary nature of most environmental outcomes often goes hand-in-hand with their non-quantifiability. This is not always the case, though it has been confined to specific outcome types in the research so far, namely the loss and gain of habitat area (Wilson et al., 2008; Vogdrup-Schmidt et al., 2019). Where outcomes are not quantified – such as in

message framing interventions that involve more general statements of "improving" or "deteriorating" the atmosphere– the choices may be more difficult to interpret, appraise and compare. Loss aversion in these circumstances would suggest that it could be a purely linguistic device without real-world implications.

Other non-monetary goods, for which loss aversion has been investigated, primarily belong to the health domain. Research that has assembled loss aversion effects on health behaviour includes Rothman et al. (2006) who find that loss-framed appeals are less effective than gain-framed appeals when communicating disease prevention but more effective for disease detection. A small (corresponding to r = .03) but statistically significant greater effectiveness of gain frames relative to loss frames in ensuring compliance in this sector was also corroborated through a meta-analytic review conducted by O'Keefe and Jensen (2007). A topical study on compliance with public health measures in the aftermath of the Covid-19 pandemic found that emphasising the deaths caused by a lockdown was no more effective than emphasising the lives saved (Sanders et al., 2021). In the charity domain, Xu and Huang (2020)'s meta-analysis finds gain-framed appeals for donations to be slightly (r = .03) more persuasive. An intriguing connection between loss aversion and social image was made by Savikhin Samek and Sheremeta (2014): their experiment on the impact of revealing the (highest or lowest) contributor to a public good showed that individuals are more motivated by avoiding shame than they are by achieving prestige. Alluding to prospect theory, the authors argue that the loss of social image was more powerful than a corresponding gain.

Second, the public nature of the good also has additional implications for the decision process, since the interpretation of the goal changes: environmental degradation is seen as a collective, rather than private loss. Even when environmental impacts can include consequences for the individual, this linkage is less palpable than in areas where the impacts are private (such as personal health or savings), requiring conscious thought processing to register, connect and act upon. As Wilson et al. (2008) argue, people have difficulty conceptualising how others experience gains and losses. In line with the false uniqueness effect (Chambers, 2008), which is particularly strong for negative emotions such as those associated with loss (Jordan et al., 2011), individuals may believe their losses are unique and underestimate the losses experienced by others (Wilson et al., 2008).

Loss aversion has been reported for other public goods as well, namely in the domain of politics. Alesina and Passarelli (2019), for example, lean on loss aversion to explain apparent voter inertia when it comes to voting for redistributive policies, even when these would have been preferred by the median voter if the status quo was irrelevant. Negotiations have also been argued to be more complicated in the presence of loss aversion, as negotiators are less likely to reach an agreement if the attributes being bargained over are framed as losses than when they are framed as gains (Bazerman and Carroll, 1987). By contrast, Wilson et al. (2008) observe that individuals that are loss averse when making financial decisions do not exhibit loss aversion when it comes to social or environmental issues. The authors find that although their experimental subjects did experience a pain from losses, the magnitude of this

feeling was equivalent to the pleasure experienced from gains, which is more in line with the normative, utility based model.

Loss aversion has three clear practical extensions: default and status quo bias, the endowment effect, and loss framing. Below I provide a brief overview of implications for environmental decisions from default and status quo bias, and the endowment effect, whilst section 2.1.7 focuses on loss framing. Chapter 2.2 is dedicated to an empirical review of the effects of loss framing on pro-environmental decisions.

Default and status quo bias. Loss aversion activates the status quo bias (Tversky and Kahneman, 1991), defined as the preference given to the current state of affairs relative to any change from it (Samuelson and Zeckhauser, 1988). Related to this is the default bias, the bias that favours the preselected option among a list of alternatives (Johnson and Goldstein, 2003).

When it comes to pro-environmental behaviour, the nudge that leverages the default bias has shown to be the most consistently effective. Following a natural field experiment at a Swedish university where the default printer settings were changed to double-sided printing, Egebark and Ekstrom (2013) report on a 15% drop in paper consumption. Brown et al. (2012) find participants in an experiment accepted a lower default temperature on thermostats, whilst Pitchert and Konstantinos (2008) present a number of real world examples in Germany, where people chose 'green' electricity in favour of 'grey' electricity when the former became the status quo option.

It is important to note that the status quo bias can be induced even in the absence of loss aversion, due to, for instance, transaction costs, costs of thinking and prior commitment (Samuelson and Zeckhauser, 1988). Similarly, opting for the default option among a list of choices can occur not only as a result of loss aversion, but also due implied endorsement by the 'choice architect' or inertia (Sunstein and Reisch, 2013).

Endowment effect. A second immediate consequence of loss aversion is the endowment effect, the phenomenon whereby individuals suffer a greater loss in utility when giving up a good than they experience a gain in utility when receiving it (Thaler, 1980). One method for analysing the endowment effect with respect to pro-environmental behaviour has been to quantify the disparity between the maximal amount people are willing to pay for an environmental good (WTP) and the minimal amount they are willing to accept to give it up (WTA). For instance, in an empirical study by Hammack and Brown (1974), hunters stated they would be willing to pay $247 for a program that prevents loss of wetlands but would demand $1044 to 'accept' such a loss.

Other researchers have leaned on loss aversion to explain the observed discrepancy between contributions to common pool resources and public goods (Sell and Son, 1997). The former involve decisions to refrain from taking or take in moderation (avoid a loss), whilst the latter involve decisions to give or create (achieve a gain). As Sell and Son (1997: 124) posit, "the endowment effect and loss aversion should 'push' group members to contribute more to resources goods than to public goods". The authors indeed found this to be the case, but only in one-shot games or games without interaction; when interaction was present, contribution to

public goods and to common pool resource goods converged. Similarly, the endowment effect would predict that the willingness to pay for environmental restoration post-disaster should be higher than the willingness to pay for environmental improvement or conservation (where the individuals are assumed to be 'endowed' with the environment), yet Le Coent et al. (2017) did not find this to be the case.

2.1.6 Loss framing

Levin et al. (1998, p. 150) define framing as phenomena where "decision-makers respond differently to different but objectively equivalent descriptions of the same problem". Concretely, valence framing "casts the same critical information in either a positive or a negative light" (ibid.), keeping constant other message content that may affect the preference structure. As such, framing departs from neoclassical economic theory of utility optimisation based on rational expectations, which would consider the presentation of information only one among many 'supposedly irrelevant factors' (Thaler, 2015).

Levin et al. (1998) categorise valence framing into risky choice framing, attribute framing and goal framing. The first, considered the 'original' framing effect used by Tversky and Kahneman (1981), involves framing a set of choices in terms of their associated risk. Through this, the two authors bring together the concepts of loss aversion and risk aversion, proposing that people are risk-seeking for prospective losses and risk-averse in the gain domain. Throughout their empirical research on loss framing, Tversky and Kahneman (1981) focus on monetary outcomes. In attribute framing, the same object is described either positively or negatively; without risk, positively framed characteristics were empirically shown to be preferred (Levin et al., 1998), though less can be said about behaviour. Finally, goal framing characterises information depending on whether it emphasises the potential gain or loss resulting from a certain action. As the authors emphasise, goal framing is the most complex in terms of the number of potential permutations: each frame involves two possible consequences of an action, namely obtain gain or avoid loss (positive frame), and forego gain or suffer loss (negative frame); it can also vary in terms of whether negation (not doing the action) or alternative terminology (carrying out a different action) is used (Levin et al., 1998). Since persuaders use different goal frames to encourage the *same* outcome (ibid.), they can not only test, but also manipulate the loss aversion bias to fit their purpose.

In sum, loss framing can be defined as the presentation of information to emphasise the losses that would result from a certain action. In the context of pro-environmental behaviour, a loss-framed message is one that emphasises the negative outcome on the environment from carrying out an action that harms it.

The notion of goal framing used by Levin et al. (1998) – and, by extension, in this thesis – can be distinguished from the one used in psychology, where messages differ according to which goal (normative, gain or hedonic) is made salient (Lindenberg and Steg, 2007). It also distances itself from interventions that leverage theories, which consider behaviour as an entirely conscious endeavour, such as the theory of planned behaviour (Ajzen, 1991). The reasoning is that the fundamental premise of valence framing is keeping all these factors

constant so as to isolate the effect of 'supposedly irrelevant factors', including biases related to framing effects. A review of the empirical research done on loss framing in the environmental domain to date is provided in chapter 2.2.

2.1.7 Practical implications

At the individual level, interventions to encourage pro-environmental behaviour can be justified by appealing to tenets of neoclassical economic theory:

- *Cost-benefit delay*: there is a temporal gap between the benefits of the behaviour (e.g. satisfaction derived from it) and its cost – here, the negative impact of humans on the environment.
- *Decision-making under uncertainty:* individuals are not equipped with perfect information about the outcome of their decision. There is a lack of clarity over the environmental impact of a decision and, particularly, how this compares between two or more choices (for instance, is it better for the environment to buy organic produce from far away or local non-organic produce).
- *Lack of feedback:* the environmental outcomes of our choices are not always salient (natural catastrophes on the other end of the globe).
- *Negative externalities:* prices of a good do not capture all of its costs, but exclude environmental costs such as pollution.

It follows that even under the assumption of rationality (which the above features of decision-making are in line with) individuals do not make utility-maximising decisions. Environmental economists address these issues through market-like incentives and market-based approaches, such as marketable permits, Pigouvian taxes and mechanism designs. From a behavioural economics perspective, these phenomena call for the introduction of pro-self nudges. The environmental economist's policy toolkit rests on the assumption of rational behaviour, which is problematic because nature's 'goods' and 'services' cannot be characterised by market-like arbitrage that is needed to encourage consistent decision-making (Crocker et al., 1998). To avoid the overuse or under-provision of public goods, we can employ the second type of nudges – pro-social nudges- which do not necessarily explicitly aim to correct for non-rational individual decision making (Carlsson et al., 2021)

In line with nudge theory, people respond not only to information, persuasion and monetary incentives, but also to how the interventions are formulated and communicated. Environmental sustainability goals can, then, be pursued by targeting cognitive biases. Nudge theory may suggest using nudges that either attenuate these biases or leverage them; they can be used to:

i. Trigger System 2 reaction (bias mitigation) – run interventions that prompt the individual to resort to System 2 rather than System 1, where preferences are characterised by higher environmental concern. This should increase the conversion rate between pro-environmental attitudes and behaviour.

ii. Target System 1 (bias leverage) – run interventions that *circumvent* preferences, where these are characterised by low environmental concern.

Dolan et al. (2012) present a similar classification of nudges in their 'Mindspace' model, dividing them into the 'cognitive' System 2 – i.e. those that people consciously think about – and the 'context' System 1 nudges. In the latter, nudges purposefully shift individual attention away from information and towards the context within which they make the decision. The contrast here is that the first group of nudges I introduced above do not assume conscious thought processing already exists, but seek to trigger it where it is absent.

Nudges are only one instrument of environmental policy - one which is especially effective *in combination* with "money pumps" or economic incentives based on rational choice theory (Shogren, 2012). They can also be used to complement restrictive instruments such as command and control measures (i.e. targeted to increase their compliance) and softer, information and moral suasion campaigns.

Green nudges can involve changing the default option, the order options appear in, or the frame of- and information provided in the environmental appeal. They can also include reminders, commitment devices and changes to the physical environment. Below I provide a brief overview of two types of green nudges that have been tested frequently; nudges related to loss aversion will be analysed in the next chapter.

Information provision or simplification: owing primarily to its simplicity of investigation and implementation, information provision is the most common type of green nudge employed. Yet, there is mixed evidence on its success in practice. Seifert et al. (2022) found that additional information on the financial return of investments or on their environmental impact both increased the share of sustainable investments. In the energy domain, sales of energy-efficient appliances increased following the introduction of a more informative label in Stadelmann and Schubert's (2018) study, but not in Allcott and Sweeny's (2017) study, whilst Kallbekken et al. (2013) find the evidence to be inconclusive. Graphic improvements to information have shown to be more effective. Tiefenbeck et al. (2016), for instance, provided real-time feedback on energy use while showering through an animated visual of a polar bear standing on ice; this led to a 22% reduction in the average shower time.

Social comparison: environmental appeals that include social comparison rest on the assumption that people exhibit herd behaviour and conform to social norms, sometimes even without a corresponding change in their own conscious attitudes towards a particular outcome (Young, 2015). Since an individual's behaviour is affected by his or her *expectations* of the behaviour and attitudes of others, a role of policy can be to provide reasons for these expectations to change (Young, 2015). Social comparison can be particularly effective in unfamiliar situations where individuals are likelier to look for cues to guide them towards a decision (Carlsson et al., 2021). A number of studies have been conducted involving social comparison to reduce energy consumption (Ayres et al. 2013; Asensio and Delmas, 2015; Sudarshan, 2017). Allcott (2011), for instance, reports on a 1.9-2.0% reduction in energy consumption following the distribution of leaflets that contain information on others' energy

usage, a natural field experiment conducted by OPOWER. Elsewhere, littering was found to be less prevalent when experimental subjects were not presented with a littered area or did not see someone else who littered (Cialdini et al., 1990).

2.1.8 Alternative explanations for pro-environmental behaviour

Whilst behavioural economics has been enjoying increasing attention recently, it remains overshadowed by the more traditional theories of rational behaviour for explaining pro-environmental attitudes, intentions and behaviour. At the heart of a number of these theories is rational choice theory. Rational choice theory posits that individual behaviour results from conscious weighting of its expected costs and benefits (Scott, 2000). In undertaking this process, individuals have perfect information about the task and are purely rational, in the sense that their actions reflect their preferences about the behaviour (see Table 2). The rational choice model has guided most of both policy and research. In a recent systematic literature review on green consumption, ElHaffar et al. (2020), for instance, find that only 10 out of 58 articles build on behavioural science to explain the "green gap", the rest leaning on the rational paradigm.

(i) Economics: expected utility theory

According to expected utility theory within the neoclassical economic school of thought, individuals make a decision about an action with uncertain outcomes so as to maximise their expected utility from it (Bernouill, 1713, in Stigler 1950). Mathematically, the action yielding the highest expected utility is the one where the sum of the products of utility of an outcome and the probability of it occurring, over all possible outcomes, is maximised. The theory rests on the assumption that individual preferences are well-defined, consistent and transitive, together defining rational conduct (Von Neumann and Morgenstern, 1944).

In terms of environmentally-relevant decisions, expected utility theory would predict that people will behave pro-environmentally when the benefits of doing so outweigh the costs. Since for this domain costs are typically individual, immediate and tangible (financial outlays, but also time and effort), whilst benefits are often collective and temporarily distant, pro-environmental behaviour should be rare. As with other pro-social decisions, environmental decisions can also be thought of as altruistic and/or yielding a warm-glow, which can be incorporated into the utility function.

Expected utility theory has been the subject of much criticism not addressed solely at the rational choice paradigm it belongs to. One additional critique is that people's evaluation of outcomes is done with reference to a benchmark; what matters for utility are changes rather than absolute values (Prospect theory – Kahneman and Tversky, 1979). Fundamentally, expected utility theory does not allow for the numerous heuristics and biases in people's judgement and behaviour, since what matters to the theory is the expected payoff of outcomes rather than the way, for instance, choices are presented[4]. Despite its drawbacks, expected

[4] Since behavioural economics as a discipline was born out of the critique of expected utility theory underscoring most economic research, a discussion on all criticisms this theory is subject to would constitute a circular

utility theory makes economics more mathematically rigorous; as Thaler (2018, p. 491) argues, neoclassical theories remain useful as "benchmarks on which to build descriptive theories".

(ii) Environmental and social psychology: theory of planned behaviour

The theory of planned behaviour, formulated by Icek Ajzen (1991), seeks to explain and predict human behaviour through its cognitive antecedents, the most immediate of which is behavioural intention. Intention to carry out an action, in turn, is guided by situation-specific attitudes, by beliefs of the expectations of others (subjective norms) and by beliefs about one's own control over the action (perceived behavioural control). It is one of the most widely used theories to explain individual behaviour generally (cited more than 100,000 times by 2022), and environmentally-relevant behaviour specifically. In environmental psychology it has been used to explain recycling (Echegaray and Hansstein, 2017; Botetzagias et al., 2015), energy use (Gao et al., 2017; Abrahamse and Steg, 2011), and transportation (e.g. De Groot and Steg, 2009), among others.

Problematically, this theory, too, assumes that people are inherently rational (Ajzen and Fishbein, 1980). This is reflected in the direct link between intentions and behaviour, which fails to account for contextual factors that may influence behaviour without influencing intention. It also cannot explain the empirical gap between intentions and behaviour, discussed in section 2.1.9.

(iii) Environmental psychology: value-belief-norm theory

The value-belief-norm theory was developed by Stern et al. (1999) specifically for pro-environmental behaviour. The authors argue that values – leaning on Schwartz's (1992) classification of biospheric, altruistic and egoistic values – influence beliefs, which affect personal norms, finally influencing behaviour (Stern et al., 1999). To them, environmentally-relevant behaviour can be categorised further into activism, non-activist behaviour in the public sphere, private sphere behaviour and behaviour in organisations. The key component of this theory are personal norms, defined as a "sense of obligation to take pro-environment actions" (Stern, 2000, p. 412). This is the only consistent predictor of all non-activist types of pro-environmental behaviour, write Stern et al. (1999).

Compared to the theory of planned behaviour, the value-belief-norm theory is more concrete in the attitudinal factors it claims shape pro-environmental behaviour, but fails to include determinants to capture intent. The value-belief-norm theory also goes further in the additional non-attitudinal factors that are postulated to drive behaviour: in addition to the opportunities and sufficient resources to perform the behaviour already highlighted within the theory of planned behaviour (Ajzen, 1991), a factor Stern calls "personal capabilities", Stern (2000) identifies context (infrastructure, financial incentives) and habits as two further important determinants of behaviour. With this, he comes just short of acknowledging the importance of subconscious factors that may influence individual behaviour.

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reference. I instead direct the reader to the beginning of this chapter where the theories at the heart of the behavioural economic discipline are discussed.

Environmental psychology can be seen as the key academic discipline for studying and understanding individual pro-environmental behaviour, yet has been criticised for relying strongly on self-report measures (Steg and Vlek, 2009). Examining all articles published in Journal of Environmental Psychology in the years 2015 and 2016, Lange et al. (2018) find that 80% of them rely exclusively on self-reports, i.e. self-reported behaviour and antecedents of behaviour (attitudes, intentions). Due to their inconsequentiality, self-report responses may not be very informative for understanding an individual's actual socially-relevant behaviour (Lange and Dewitte, 2022; Klein and Hilbig, 2019) – see also section 2.1.9.

All three of the above theories explicitly or implicitly assume 'well-behaving' preferences: that people know what their preferences towards a particular behaviour and outcome are, that these are consistent, and that they are acted upon if only the conditions (infrastructure, context and so on) are right.

Table 2: The rational choice and behavioural paradigms

	Behavioural, dual process, paradigm	**Rational choice paradigm**
Assumptions	Two cognitive processes	Rationality – people have well-formed preferences and behaviour to reflect them
Policy interventions	Nudges: choice architecture, emotional appeals	Information campaigns, regulation, financial incentives
Disciplines	Behavioural economics, psychology	Economics, psychology, sociology
Theories	Dual process theory Prospect theory Nudge theory	Expected utility theory Theory of planned behaviour Theory of reasoned action
Cognitive culprits for attitude-behaviour gap	Automatic cognitive processes	Reflective, deliberative cognitive processes

Source: author's own

2.1.9 Gap between stated preferences and real behaviour

First, I provide some important definitions. As defined at the outset, stated preferences include attitudes, behavioural intentions and willingness to pay for an outcome, as articulated by the individual. Real behaviour, by contrast, refers exclusively to actual conduct observed by the researcher. Where the two constructs do not match, we may have one of the following:

- *Attitude-behaviour gap:* a discrepancy between attitudes towards an outcome and the corresponding behaviour needed to achieve it.
- *Intention-behaviour gap*: a discrepancy between intention to carry out an action or act in a particular way, and actually doing so.
- *Hypothetical bias*: the quantitative gap between how much individuals say they are willing to pay for a good or service and how much they actually pay (Harrison and Rutstrom, 2008).

(i) Empirical evidence

An (albeit dated) meta-analysis of meta-analyses, capturing 82 thousand participants and 422 hypotheses, found that intention accounted for 28% of the variance in behaviour, on average (Sheeran, 2002). Where intention and behaviour were dichotomous variables, an average of 44% of individuals who expressed intention to carry out an action failed to do so.

A more recent meta-analysis (Penn and Hu, 2018) finds mean hypothetical bias (ratio between hypothetical and actual willingness to pay) to be 2.29, with a large range between -37.10 and 48.39. In a study that compared consumer choice tasks that were either fully consequential (carried both costs and benefits), partially consequential or hypothetical (i.e. with no consequences), Klein and Hilbig (2019) were able to establish that, once real, consequences affect both the willingness to purchase a product and the preferences for different products. Specifically for the environmental domain, individual studies that measure both constructs show a clear gap. In Seip and Strand's (1992) experiment, for instance, 64 out of 101 participants expressed a willingness to pay for a membership fee for an environmental association, yet only 6 (9%) of those actually paid. Similarly, Bouma and Koetse (2019) find hypothetical willingness to pay to be 3.5 times higher than actual payment towards farmers' land conservation. A meta-analysis on the relationship between self-reported measures of preference and actual behaviour found that although self-report measures (including behavioural intentions) were correlated with objective behaviour, 79% of the variance in this correlation could not be explained (Kormos and Gifford, 2014).

For attitudes, gaps are even greater, especially when wider environmental concern is asked after. A Eurobarometer (2021) poll finds that 93% of EU citizens view climate change as a 'serious' or 'very serious' problem, and yet: only 11% of newly registered cars are electric (EEA, n.d), an albeit admirable jump from 3.5% in 2020; 22% of energy consumed stems from renewable energy sources (Eurostat, 2022a); and 9% of EU agricultural land is used for organic crops and produce (Eurostat, 2022b). Whilst 63% of EU citizens believe it is national governments that are responsible for addressing climate change (Eurobarometer, 2021), only 4% of members of parliament across the union belong to a green party[5].

Studies show similar results. Meta analyses find low correlation between general attitude towards the environment (environmental concern) and behaviour: at most 10 % of variation in pro-environmental behaviour can be attributed to differences in environmental concern (Bamberg, 2003).

Different schools of thought offer different reasons for the gap between attitude, intention and willingness to pay, on the one hand, and behaviour on the other. With the aim of being comprehensive while at the same time avoiding erroneous attribution, I provide the viewpoints of these intellectual traditions rather than individual theories.

[5] Own calculations based on individual nation-state government compositions

(ii) Economics

It is important to note that the economics discipline concerns itself with monetary decision-making. Thus, preferences are most often than not expressed in units of currency, less often as a dichotomous behavioural variable. Stated preference in economic studies is measured through contingent valuation or choice modelling, while revealed preference is reflected in actual purchases. Three explanations for the gap between stated (both attitudes and intentions) and revealed preferences have been identified in the literature: experimental design, rationality and cost of action.

In terms of experimental design, Carson and Groves (2007) argue that stated preference studies suffer from a lack of consequentialism and incentive compatibility. To ensure the stated preferences reflect true preferences, economic experiments must (1) use a binary choice format of the valuation question, and (2) ensure consequentiality, i.e. respondents must care about the good or policy being evaluated and believe their choices in the survey have consequences in real life. One mechanism for the second condition is to provide financial incentives for truthful preference revelation.

A second line of thought seeks to explain the gap through rational choice. For public goods, in particular – or rather, individual financial contributions towards them – willingness to pay valuations exceeding actual payments go hand in hand with the free rider problem. It is the rational decision that reflects strategic behaviour since higher expressed willingness to pay increases the chance that the public good will be provided (Harrison and Rutstrom, 2008), thereby increasing own utility. People may also gain utility by simply expressing a positive attitude towards an action, especially one that signals social responsibility (Taylor and Brown, 1994), since this strengthens their positive self-image. As Kahneman and Knetsch (1992, p. 57) write, "Contingent valuation responses reflect the willingness to pay for the moral satisfaction of contributing to public goods, not the economic value of these goods."

Finally, scholars have proposed the low-cost hypothesis, which sees price of an environmental good as the link between environmental concern and behaviour. The low-cost hypothesis of environmental behaviour (Diekmann and Preisendorfer, 2003) postulates that the strength of the effect of environmental concern on behaviour increases with decreasing costs of that behaviour. In other words, an individual with pro-environmental attitudes will undertake the corresponding behaviour when the costs of doing so – in terms of either money, time or effort – are sufficiently low. This is because when costs are low, explain Diekmann and Preisendorfer (2003), the utility of carrying out the pro-environmental behaviour – in particular from complying with the norm or reducing own cognitive dissonance – may compensate for its cost relative to the alternative.

Farjam et al. (2019) tested the effect of environmental attitudes on behaviour in an incentive-compatible online experiment. Manipulating the financial pay-off, they found that, consistent with the low-cost hypothesis, environmental attitudes affected behaviour only when the monetary sacrifice of doing so was relatively small. Importantly, experimental results also showed that low-cost actions crowd-out high-cost ones, which are typically more effective in reducing CO_2 emissions. This suggests, they argue, that climate policies that seek to improve

attitudes alone will have limited reach; instead, tariff-based and other prescriptive measures may be more appropriate (Farjam et al., 2019).

(iii) Environmental psychology

Environmental psychologists also lean on the rational choice paradigm for explaining the attitude-behaviour and intention-behaviour gaps[6]. As a preliminary note, both may be partially explained away by differences in measurement (e.g. Sheeran, 2002). Often the measured attitudes are broader in scope ('environmental concern', 'climate change') than the measured action (e.g. 'recycling', 'investing in solar panels'). This was indeed a key assumption in the theory of planned behaviour: a sufficiently strong relationship between attitude and behaviour rests on the correspondence principle – the consistency of action, goal, context and time (Ajzen and Fishbein, 1977). One challenge with this theoretical assumption is its practical applicability. It is much more laborious and inefficient to collect attitudes towards specific behaviours or behavioural outcomes. What is more, it is subject to disagreement over what constitutes a 'specific behaviour', particularly in terms of frequency and amount: do we match a positive attitude towards buying organic produce to purchasing an organic item every so often, purchasing one organic item with every shopping trip, purchasing a few organic items, purchasing everything organic and so on.

Kollmuss and Agyeman (2002) divide drivers of the attitude-behaviour gap into external and internal factors. External factors include infrastructural barriers, financial costs and cultural norms. Steg and Vlek (2009) build on this by proposing that contextual factors operate in four different ways: direct effect, moderation through attitudes and norms, moderation through motivation, and effect of personality traits on strength of impact of context on behaviour. Internal factors, according to Kollmuss and Agyeman (2002), include motivation, environmental knowledge and awareness, values, emotional involvement and responsibility.

Though comprehensive, Kollmuss and Agyeman's (2002) framework cannot be used to elucidate why individuals do not undertake some behaviour they expressed intention for. To overcome this, Sheeran (2002) proposes the following determinants of the size of the gap between intention and behaviour. First, whether the behaviour predicted is a particular action or a goal (which can be achieved through a number of different actions). Second, concreteness of implementation intentions, whereby "I intend to do X in situation Y" is more specific and thus more predictive of behaviour than "I intend to do X". Further, genuine ability to carry out an action, including knowledge of how to execute it, physical ability to do so, financial and other resources, opportunity to carry out the action, cooperation of others involved, availability of infrastructure or material, as well as any unexpected situations. Sheeran (2002) also evokes personality and cognitive variables such as anticipated regret and conflicting intentions. To this, we may add personality traits such as self-control, conscientiousness and forgetfulness, to name a few. Wyss et al. (2022), for instance, experimentally find that self-control strengthens the link between attitudes and behaviour, and Redondo and Puelles (2017)

[6] Whilst the discipline of psychology includes both the rational choice paradigm and dual process theory, environmental psychology research almost exclusively leans on the former.

propose that self-control is a moderator of the effect of perceived behavioural control on behaviour.

Using the language of dual process theory, we can say that, leaning on the rational choice paradigm, ideas from the two schools of thought described above assume the barriers hindering pro-environmental preferences being reflected in behaviour belong to the reflective, deliberative cognitive processes. What both of these narratives miss is the possibility that behaviour occurs unintentionally and that it is systematic and predictable in doing so.

(iv) Behavioural economics

A third explanation sees behaviour as a result of heuristics in judgment and decision making, justifying an absence of conformity with stated preferences. Dual process theories of the mind and the associated empirical evidence evoke the possibility that, everything else equal, individuals make different environmentally-relevant decisions simply because they relied on intuition (System 1) or reflection (System 2) (Lohse et al., 2016). System 1, in turn, is characterised by cognitive biases to a greater extent than System 2. This can lead to a gap between the behaviour and the outcome-relevant preferences. To avoid redundant repetition, I would refer the reader to section 2.1.4, where this is expanded on.

2.2 Empirical review of the effects of framing on pro-environmental decisions [7]

I present a systematic review of the empirical literature on the use of framing to encourage pro-environmental decisions. The aim is to bring together and characterise the relevant body of research, and to put forward a critical analysis of this evidence for researchers to build on and policy makers to use in practice.

The studies collected by this review represent an important contribution to behavioural economic theory and to policy. Their theoretical strength lies in extending the loss aversion hypothesis from private to public goods. Many also investigate the circumstances in which- and mechanisms through which loss framing may be (more) effective. Bringing these moderating and mediating effects together allows us to identify patterns and understand which pieces of knowledge are still missing.

In terms of normative application, loss framing presents a low-cost and non-intrusive policy option for motivating green behaviour. Insofar as there exists a gap between what people know and how they behave (Courtenay-Hall and Rogers, 2002), conveying information on the need to protect the environment may not be enough; what matters is *how* it is communicated.

To my knowledge, there exists no systematic collection of research into the effects of framing on green behaviour. Green nudges other than framing have been brought together by, among

[7] An earlier version of this chapter was published in co-authorship with prof. dr. Ljubica Knežević Cvelbar as "The effects of framing on pro-environmental decisions: a systematic literature review" in Ecological Economics (2021).

others, Farrow et al. (2017) who categorise the use of social norm interventions, Andor and Fels (2018) who look at interventions targeting domestic energy conservation, and Koop et al. (2019) who review studies targeted at increasing household water conservation.

Applied to the environmental context, the loss aversion hypothesis and associated negativity bias predict that framing an environmental consequence as a loss will be more effective in inducing targeted behavioural change. Work examining the role of valence framing so far has produced mixed results. Gain frames led to improved attitudes about recycling (Loroz, 2007), but loss frames were more effective in changing recycling behaviour (Poortinga and Whitaker, 2018). Attitudes may be improved following a gain frame when it comes to pollution and climate change (Feinberg and Willer, 2011), but not biodiversity conservation (Faccioli et al., 2019). Adding to the number of layers, the effectiveness of loss and gain framing is also not consistent in its moderating and mediating effects, including different message sources (Lord, 1994), emotions (Baek and Yoon, 2017) and construal level (White et al., 2011).

Proceeding from this complexity, my research interest is thus not only whether loss aversion can or cannot be applied in the context of pro-environmental behaviour, but also when and under which circumstances. This review aims to complement the existing literature by providing insights into the prospects for leveraging the loss aversion bias to achieve environmental sustainability goals, and – by assessing the effectiveness of moderators, mediators and nuances in wording – moving us collectively to a greater understanding of when and why framing works.

2.2.1 Scope and methodology of the review

Following Levin et al. (1998), loss aversion is considered distinct from decisions surrounding risk. Whilst some researchers have made attempts at consolidating the two (Loroz, 2007; Frederiks et al., 2015), the level of risk associated with green actions – and, particularly, the risk perceived and accepted by the decision-maker – is unclear. It would thus be too precarious to draw conclusions on value function implications in the context of pro-environmental decision making.

Another remark regarding the scope is that in the studies reviewed, the implicit reference point is the current state (subjectively perceived), which is how it will be treated here as well. It is important to note, however, that people's reference point when making an environmentally-relevant decision may be their expectation of what the future state is, which would influence their subjective interpretation of gains and losses (for an interesting discussion, see Osberghaus, 2015).

The analysis follows the categorisation of pro-environmental behaviour proposed by Defra (2008) to include behaviour relating to personal transport, energy usage, water usage, waste production and management, and green consumption. To these, I added biodiversity conservation and pollution & climate change to better represent the studies captured in the

review. As elsewhere in the thesis, I make a distinction between preferences and actual behaviour.

Systematic literature reviews identify, select and critically evaluate a specific research area (Dewey and Drahota, 2016). They are categorised by a clearly defined protocol (search strategy), plan and ex-ante specified criteria for the evaluation of identified research. Their strength lies in their rigor, transparency, clarity and replicability (Petticrew and Roberts, 2008). This method has also been criticised for excluding certain relevant research: reports, books, working papers, unpublished articles – therewith making them prone to the publication bias suffered by these very articles – as well as articles with poorly written abstracts (Egger, 2001). Nevertheless, systematic reviews of the literature remain a powerful tool for mapping out past, present and current research (Mulrow, 1994)

A systematic literature review was considered the most suitable method for addressing the research question as it allows me to identify for analysis all relevant articles in a transparent, unbiased and rigorous manner (Pickering and Byrne, 2014). The research did not lend itself to a meta-analysis due to the limited potential for making meaningful aggregate statistical comparisons from the wide heterogeneity of framing interventions tested (in terms of type of pro-environmental behaviour, independent variable and type of framing), combined with relatively small sample size.

My five-stage approach broadly follows the guidelines proposed by Wolfswinkel et al. (2011): (i) criteria selection; (ii) literature search; (iii) selection and refinement; (iv) analysis; and (v) presentation.

(i) Criteria selection

As a first step, I outlined the scope of the review, based on which I defined inclusion and exclusion criteria. As the review is concerned with interventions, I adopted the PICO criteria (an acronym for Population, Interventions, Comparators, and Outcomes) developed by the Cochrane organisation (McKenzie et al., 2019) and recommended for evidence syntheses in environmental management (CEE, 2018).

In terms of the target population, I am looking exclusively at individual decision-makers facing a consumer choice. Producers – such as farmers, firms, governments and the media – have thus been excluded from the analysis since their decision function is somewhat different. Studies exploring the effect of a different framing of the *same* message (loss or negative attributes, or gain or positive attributes) are the only interventions included in the analysis; studies that do not have message frame as the independent variable, as well as interventions that vary the aspect made salient (referred to as framing in some studies), are out of the scope of this review. The two sides of valence framing must both be examined and compared, thus excluding studies that only compare one frame with the baseline. Finally, the interventions must have been aimed at inducing change in the minds of the target population – either in the form of behaviour or some form of stated preferences.

Following from this, the only viable methods of measurement are empirical studies in the form of experiments and quantitative surveys or interviews, excluding literature reviews, theoretical papers and content analyses.

(ii) Literature search

I collected works from Web of Science using the following key words. To capture framing, the following were included in the topic: framing, messaging, goal fram*, loss fram*, gain fram*, risky choice fram* or attribute fram*. For areas of environmentally-relevant decision-making I leaned on the Defra UK classification of pro-environmental behaviours (Defra, 2008) to include the following: recycling, waste disposal, waste reduction, waste separation, food waste, compost*, transport use, green consum*, fuel efficien*, energy efficien*, water efficien*, conservation, or "environmental*, sustainable, green or ecological" behavi*.

I did not apply any time restrictions but included all studies published in peer reviewed journals in the English language until December 2019. This generated 1,445 records, to which 24 papers found manually based on my own assessment were added, yielding a total of 1,469 papers in the identification stage (see Figure 2).

(iii) Selection and refinement

Journals from 19 Web of Science research areas remained after I filtered out disciplines unrelated to our topic of search. 1,084 unique publications were exported for further analysis, of which 356 were removed during the title screening stage. The main reason for exclusion was unrelated research area (n=208), including works primarily from the health domain, followed by biology, construction, education and heritage. As a next step, abstracts and full text records were carefully independently evaluated by myself and the second author of the article; in cases of initial disagreement, consensus was reached through discussion. To assess eligibility, we used the inclusion criteria outlined in Section 3.1. This stage led to the elimination of a further 681 publications, of which 522 at the abstract screening stage and 159 after full text review. Reasons for exclusion included inappropriate methodology (n=257; primarily content analyses and literature reviews), population characteristics (n=108; capture studies of producers rather than consumers), and type of interventions (n=127 papers that did not test valence framing). The final sample included in the review for analysis was 47 articles with 61 distinct studies (see Fig.1).

(iv) Analysis

For the analysis stage I developed a detailed coding sheet (see Appendix 2). Following Campbell Collaboration (2019) guidelines, the coding scheme was designed to illustrate the main descriptive information of the body of research included, to represent the results of the studies, and to capture the features that may have led to diverging effects of framing on the outcome variables between them.

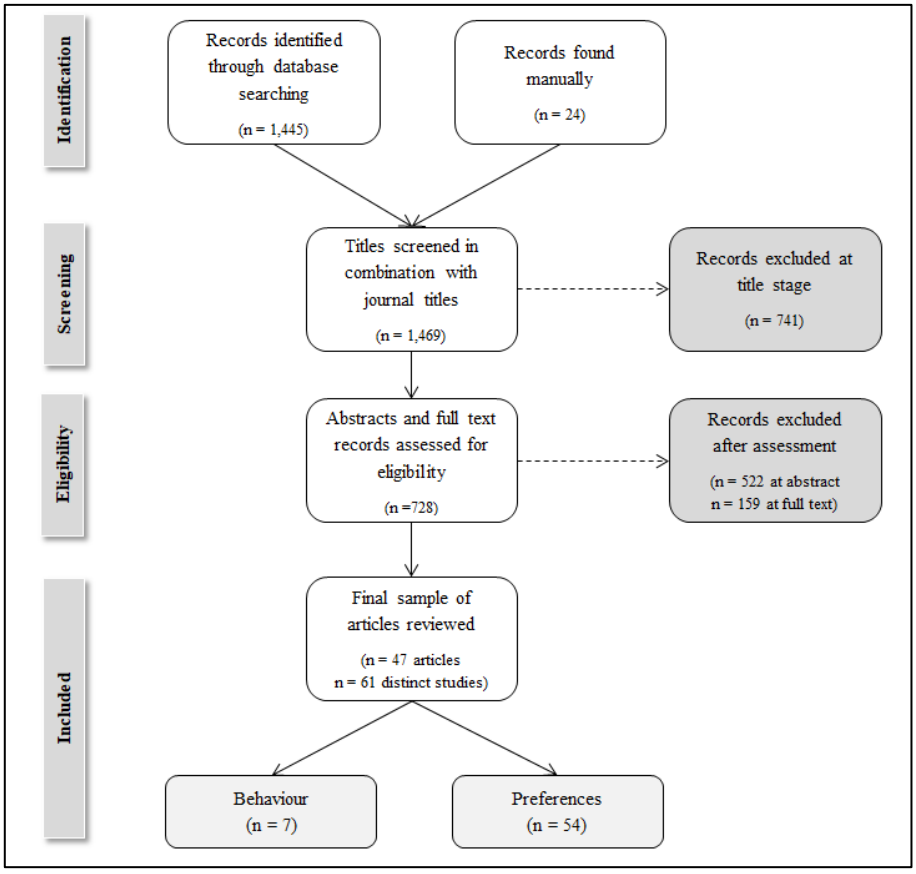
With a view to better understand the influence of loss and gain framing on pro-environmental decisions, I broke down the stated preferences group of outcome variables further into intention, attitude (towards the behaviour, the proposed policy or the message itself), stated

willingness to pay, and beliefs (e.g. in climate change), as well as three uncategorised dependent variables, namely self-reported behaviour, attention to the message and (stated) emotion. For this categorisation, I leaned primarily on the terminology adopted by the authors themselves, only combining for clarity and concision.

The two remaining studies examined emotional arousal. Affective – or, emotional – responses can be seen as (revealed) expressions of attitudes and are argued to be susceptible to framing effects due to the subjective nature of these 'mental representations' (Kahneman et al., 1999, p. 206). Though measured explicitly in the laboratory, emotional response does not necessarily lead to the targeted action, distinguishing it from actual behaviour, which is why it remains grouped together with other portrayals of preferences.

The coding sheet was condensed for the data presentation stage, as seen in the results table (tables in Appendix 3a and 3b).

Figure 2: Methodology flowchart



Note: studies with distinct samples of participants or different main outcome variable measured (behaviour versus preferences) are considered separate and analysed independently.

Source: author's own

2.2.2 Characterisation of included studies

A total of 47 articles examine the effect of valence framing on decision making and comply with our inclusion criteria. The first was published by Gonzales and colleagues in 1988 (Gonzales et al., 1988); other seminal papers include Lord's (1994) investigation into appeals for encouraging recycling behaviour and Obermiller's (1995), who uses the "sick baby – well baby" analogy in place of framing[8]. The number of annual publications on the topic was fairly constant until 2010 when it started growing rapidly: an average of 1-2 papers were published every five years between 1988 and 2010, jumping to 27 in the 2015-2019 period. This may be related to the publication of the influential book Nudge (Thaler and Sunstein, 2009), which popularised choice architecture (including framing) as a low-cost intervention option.

The 47 articles included in my review together include 61 studies that were independently analysed. Of those, only 7 measured behaviour directly, with the rest looking at stated preferences, namely intentions (30) and attitudes (26 occurrences) as shown in Table 3.

In terms of types of pro-environmental behaviour, waste & recycling and green consumption were examined most often, while water efficiency and transport use attracted the least attention (see Figure 3).

Table 3: Frequency of main outcome of interest

Outcome variable	Frequency
Behaviour	**7**
Stated preferences	**74**
Intention	30
Attitude	26
Willingness to pay	7
Beliefs	6
Other	3
Emotional arousal	2

Note. Some studies examined more types of stated preferences, leading to the difference in numbers between number of studies (54) and outcome variables (74 in aggregate).

Source: author's own

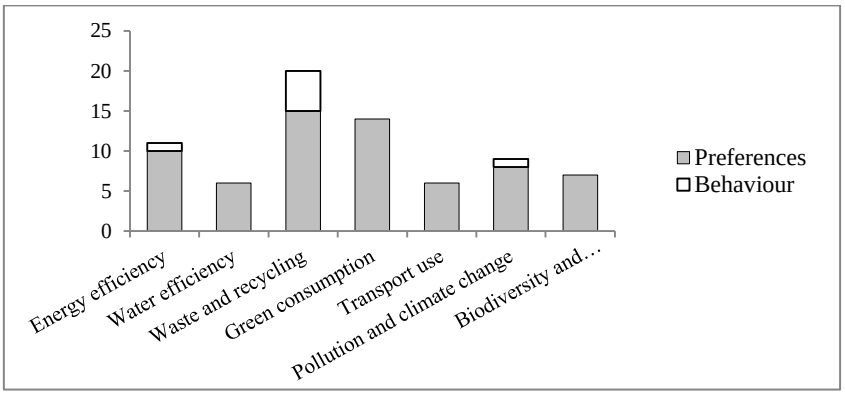
The majority of studies (89%) also investigate the effect of moderating or mediating variables, with emotion being the most prominent (13 studies). Other moderators included manipulation of (geographical, societal etc.) proximity of impact, variation of the metric used (such as annual vs. lifetime costs), change in the message source and combination of gain and loss framing with construal level.

Finally, I ask myself whether people exhibit loss aversion when it comes to non-monetary consequences, in this case to the natural environment. Whilst all studies look at environmental contexts, the messages used to achieve an environmentally beneficial outcome elicit different

[8] As per Fine's (1990) original definition, a "baby is sick" message focuses on the problem and its severity, whilst a "well-baby" appeal emphasises the need and possibility of a solution.

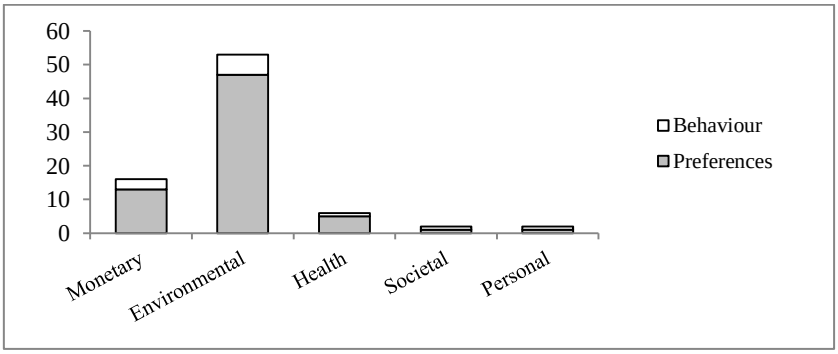
consequences: 16 studies drew the participants' attention to monetary consequences of the decision, 6 to health outcomes, and 2 each to societal or personal implications (namely, social reputation and personal satisfaction), with some appealing simultaneously to more than one type of effect. Not counting the one paper using messaging to evoke societal and personal implications of an action, a similar distribution of consequences can be observed between the real behaviour- and stated preference studies (see Figure 4).

Figure 3: Number of studies according to type of pro-environmental behaviour in focus



Source: author's own

Figure 4: Number of studies according to outcome appealed to



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2.2.3 Main findings from the review and hypothesis development

The empirical evidence suggests that loss framing is more effective than gain framing, providing support for the loss aversion hypothesis. In other words, more studies find loss- but not gain framing to lead to targeted outcome, or find loss framing to lead to this change to a greater extent. This holds for 30 studies (49%) with a further 7 finding both loss and gain framing to have an effect, depending on which moderator they are combined with, and 6 not reaching statistically significant results on the relative effectiveness of either framing valence. Gain framing was found to be more effective in 18 (30%) of the studies.

Gain-framed environmental appeals were associated with more positive attitudes towards the action or environmental outcome than the loss-framed ones. This leads to the first hypothesis:

> *Hypothesis 1: gain-framed environmental messages have a positive impact on an individual's pro-environmental attitudes.*

Importantly, when measuring actual behaviour, loss framing was always effective, with 1 of the 7 studies also finding support for gain framing. This finding from the literature joins with the loss aversion component of prospect theory discussed in chapter 2 to form the second and leading hypothesis of this thesis:

> *Hypothesis 2: loss-framed environmental messages have a positive impact on an individual's pro-environmental behaviour*

In both studies where preferences and behaviour were measured within the same experiment, gain framing led to a positive change in stated preferences but it was loss framing that led to changes in behaviour. In one, a positive attitude towards recycling following a gain frame can be contrasted with a greater tendency to recycle following the loss frame (Lord, 1994); in the other, gain framing led to more positive green attitudes but lower advocacy behaviour (Nabi et al., 2018). In three separate studies, White et al. (2011) find both gain and loss framing to improve recycling intentions equally, but the latter to lead to higher actual recycling levels. These results support the evidence on the gap between environmental concern and pro-environmental behaviour observed in the real world (see first sub-section in 2.1.9). The findings on the attitude-behaviour gap from these studies, coupled with the different results of the review for the behaviour and attitude outcome, lead to the third hypothesis:

> *Hypothesis 3a: positive attitudes following a gain-framed environmental message will not be reflected in commensurate pro-environmental behaviour.*

This hypothesis states that a message that, by invoking the positive consequences of carrying out some pro-environmental behaviour, leads to stronger behaviour-specific pro-environmental attitudes will not necessarily lead to the corresponding pro-environmental action. In other words, pro-environmental attitudes are not a sufficient condition for pro-environmental behaviour. A related question is whether they are a *necessary* condition for pro-environmental behaviour. At this point I briefly return to the second theoretical basis for loss aversion – dual process theory. This theory states that there are two types of mental processes – the fast, subconscious and intuitive (System 1) and the slow, conscious and deliberate (System 2) – which are not necessarily aligned (see sections 2.1.2 and 2.1.3 for a longer discussion). An environmentally-relevant decision, such as an action or a declaration of preferences, may be a reflection of either System 1 or System 2. This implies attitudes and behaviour do not have to match. Not only would this involve pro-environmental attitudes that are not reflected in behaviour, but it may also comprise pro-environmental behaviour that is not a reflection of attitudes. This leads me to stipulate the following:

> *Hypothesis 3b: positive attitudes following a gain-framed environmental message will not be a pre-requisite for pro-environmental behaviour*

The above evidence for the attitude-behaviour gap also warns that self-reported preferences may not be good predictors of pro-environmental behaviour. Despite this, studies rely heavily on the use of self-reported measures as a proxy of pro-environmental behaviour. The evidence here highlights the importance of testing actual behaviour in addition to stated preferences.

Treatment effects also differ within the stated preferences category of outcome variables (Figure 5): loss framing is shown to be more successful in inducing changes in behavioural intention and willingness to pay (more effective in 49% of experiments; less effective in 19%), whilst gain framing may be preferred for changing attitudes (more effective in 50% studies; less effective in 23%). Yet while none of these variables necessarily leads to changes in behaviour, theories from psychology place attitudes before intentions in the sequence of cognitive antecedents of behaviour (Ajzen, 1991). In other words, *under the right circumstances,* a change in attitude will lead to a change in intention, suggesting the former is weaker in terms of likelihood to lead to behavioural change. Indeed, looking at the number of studies, in which attitudes, intention and behaviour were positively shifted in response to a loss frame or gain frame, one can see that a behavioural change was positive only in the loss-frame experimental conditions, behavioural intention was positive in both types of conditions, but more often in the loss framed one, and attitudes were more often positive in the gain-frame experimental conditions (Figure 5). Based on this finding I form the final hypothesis of this thesis:

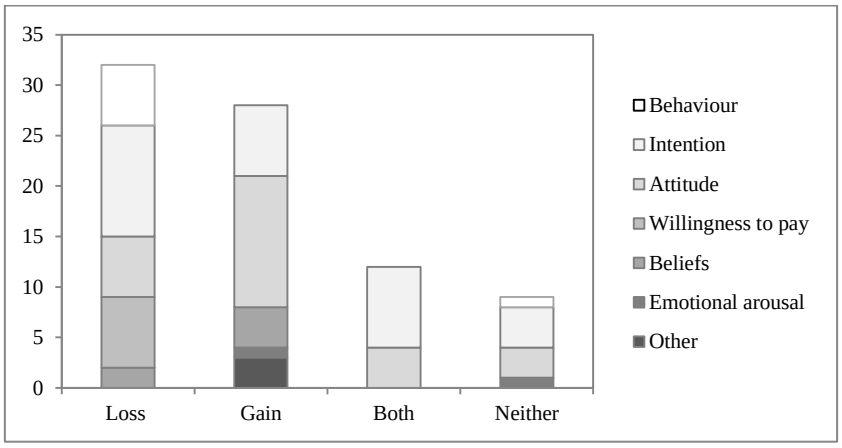
> *Hypothesis 4: positive behavioural intentions following either a gain-framed or loss-framed environmental message will not be reflected in commensurate pro-environmental behaviour*

Table 4: Summary table for effectiveness of loss and gain framing on pro-environmental decisions

Outcome variable	**Definition (change in revealed or stated preferences of participant)**	**Revealed preferences: behaviour**	**Stated preferences**	**Total**
Loss frame	*A loss frame is the only effective frame, the more effective frame or the more often effective frame in the study*	6	24	30 (49%)
Gain frame	*A gain frame is the only effective frame, the more effective frame or the more often effective frame in the study*	0	18	18 (30%)
Both frames	*A loss frame is effective with one moderator and a gain frame is (equally) effective with another moderator*	0	7	7 (11%)
Neither frame	*The effect of loss- and gain- frame does not differ*	1	5	6 (10%)
Total number of studies		**7**	**54**	**61**

Source: author's own

Figure 5: Effectiveness of loss and gain framing on different outcome variables



Source: author's own

2.2.4 Other findings from the review

Elicited consequences

Evidence also suggests people exhibit loss aversion both with respect to monetary and environmental consequences of a decision in the environmental context: of the studies appealing to environmental consequences of a decision, 26 (49%) found loss framing to be more effective, 15 (28%) favoured gain framing and 6 found evidence in support of both. Turning to messages evoking a monetary implication, 56% supported loss framing and 19% found gain framing to be more successful. Results on the effect of framing when other consequences (health, societal and personal) are evoked are inconclusive due to the small number of studies examining them.

Moderating and mediating effects

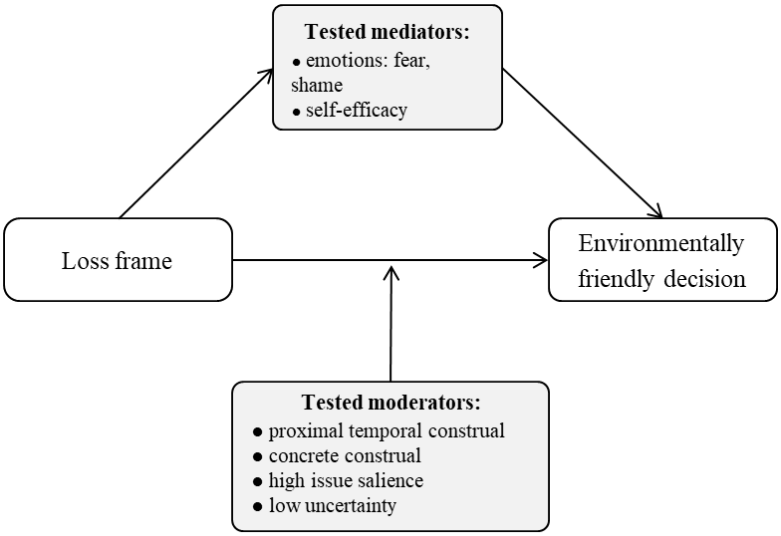
The effect of framing on environmental decisions was in some cases moderated by construal level (Grazzini et al., 2018; White et al., 2011), a concept that captures the differences in our perception of the desirability of an action's end state (high-level construal) and the feasibility of attaining it (low-level construal) (Liberman and Trope, 1998). More precisely, loss frame was found to be more effective when combined with concrete ("how") or proximal temporal construal, whilst gain frame was more effective when combined with abstract ("why") or distant temporal construal. As White et al. (2011) argue, this may be because the potential environmental consequence is more palpable as a threat in loss framing, implying pairing loss framing with concrete construal level (also a more tangible frame) leads to greater processing fluency.

The interaction of framing with stated emotion is less clear: in studies that treated emotion as a mediating variable, loss framing was shown to work through negative emotions – such as guilt, shame and fear (Amatulli et al., 2019) – but gain framing was associated with both negative (Lu, 2016) and positive emotions (Nabi et al., 2018).

Emotion has also been manipulated to serve as a moderating variable: in their studies, Baek and Yoon (2017) found that loss and gain framing can both be used to increase intention to conserve water, depending on whether they are combined with inducing a feeling of shame or guilt, respectively.

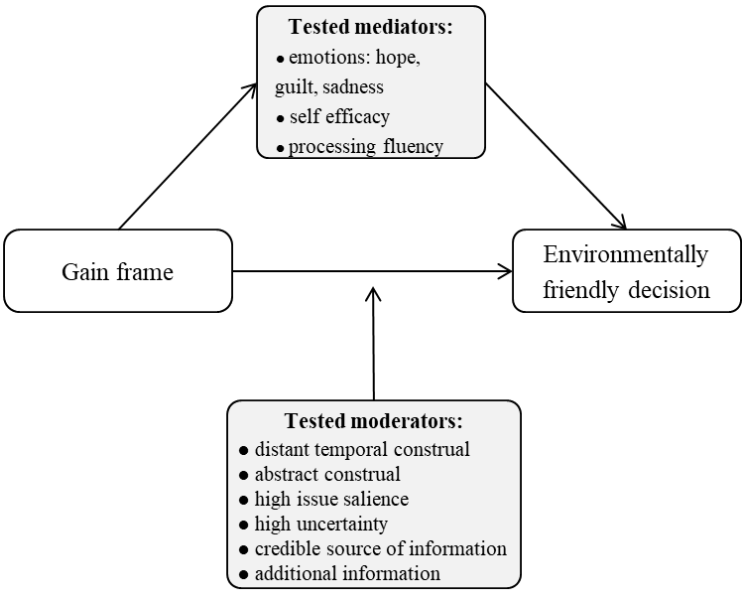
A number of other moderators and mediators were also tested, but in too few studies to draw conclusive results. Figures 6 and 7 show a summary of those shown to be effective in any of the studies reviewed.

Figure 6: Tested moderation and mediation effects - loss frame



Source: author's own

Figure 7: Tested moderation and mediation effects - gain frame



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2.2.5 Loss framing typology

The analysis has revealed that there remain several nuances within valence framing that influence outcome. Treatment messages differ based on three classifications: whether they manipulate attribute or goal framing; whether the (goal) frame appeals to an action that will cause or prevent an outcome; and whether it encourages carrying out or avoiding the action (see Table 5).

Combined with context factors discussed in section 2.2.4 the breakdown of framing into these three dimensions better equips us to understand the precise success factors for using framing, and thereby to improve both its theoretical understanding and its applicability into practice.

(i) Attribute vs. goal framing

Of the three types of framing introduced by Levin et al. (1998), goal framing has attracted the most research attention. This type was applied in 57 of 61 (93%) of the studies captured in the review and involved evoking the direct consequences of a decision on the environment. Feinberg and Willer (2011), for instance, test messages that detail the devastation that could result from global warming or the solutions that may lead to the reversal of its effects.

By contrast, attribute framing is employed in 5 (8%) of the studies reviewed (one study uses both, leading to an overlap). Messages in this category describe either a positive or negative attribute related to human impact on the environment, and were used primarily to test the effect on consumption of environmentally friendly products (Olsen et al., 2014; Tu et al., 2013). Most (3 of 5) led to no statistically significantly different results on the outcome variable of interest, supporting Levin et al's (1998) proposition – albeit on a small non-representative sample of studies – that the use of this type of framing may not be appropriate for inducing change.

(ii) Cause vs. prevention

Types of (goal) frames used can also be categorised into cause and prevention frames. Here, gain frames can be divided into information that evokes positive environmental outcomes that will (or may) happen following the decision, or environmental damage that will be avoided. Similarly, loss framed messages may be grouped into those that conjure a negative environmental outcome that will happen, or a benefit to the environment that will not, both due to the decision taken by the subject (see also Rothman et al., 2006).

Most studies (75%) employ the will-bad / will-good pair, that is, define positive or negative environmental consequences that result from the individual's decision. The message used in Davis (1995), for instance, details positive outcomes on the environment if certain green activities are undertaken (e.g. improved air and water quality), and negative consequences if they are not (reduced air and water quality). The study found the latter frame to be more effective in improving intention to act pro-environmentally. Indeed, on average in this category of experiments, loss framing had a 50% success rate (65% including studies where both frames are effective depending on the moderator), which is comparable to the average effectiveness of loss framing across all studies reviewed (see Section 4.2). Gain framing, by

contrast, was here shown to be effective only 22% of the time, somewhat lower than the 30% effectiveness overall.

Kim and Kim (2014) use a won't-good / will-good frame pair to encourage recycling behaviour: in their experiment, subjects are informed that by recycling they contribute to the preservation of the health of the planet (gain frame), whereas by not recycling they "fail to contribute" to the health of the planet (loss frame), with the former showing to be more effective in inducing changes in attitudes. The reverse won't-bad / will-bad pair was used elsewhere to encourage environmentally friendly transport use, with air pollution described either as causing the weakening of plants and emergence of pests or preventing it (Mir et al., 2016). These studies, however, are too small in number to allow conclusions on the relative effectiveness of either frame valence.

A fifth group of studies, particularly those measuring willingness to pay, test messages with actions appealed to leading to the same positive outcome: here, the loss frame captures negative outcomes that will not happen, whilst the gain frame refers to a positive outcome that will happen. Vogdrup-Schmidt et al. (2019) use this in the area of biodiversity conservation: they ask subjects to indicate how much they would be willing to donate to prevent losses of a habitat area (loss frame) or increase the habitat area (gain frame) and conclude that willingness to pay is higher when subjects are faced with the risk of losing habitat area.

(iii) Action vs. avoidance

Finally, we divide frames into those that appeal to action and those that deter it, or, alternatively, into messages that detail the consequences of an action and those that describe the consequences of inaction. We refer to it as the action-avoidance categorisation.

In the 'action' group, for instance, four studies in Amatulli et al. (2019) test messages that outline the consequences of purchasing more or less environmentally friendly products (rather than, for instance, detailing what *not* purchasing them would result in). Another representation of the action frame can be found in Ahn et al. (2015), who divide subjects into those that plant seeds and those that cut down trees in an interactive virtual reality game.

By contrast, Spence and Pidgeon (2010) use messages that describe either the positive effects of taking climate change mitigation action and negative effects of not taking mitigation action. A number of studies also use the no-action frame for losses when contrasting positive consequences of recycling with the negative consequences of not recycling (Grazzini et al., 2018; Park and Song, 2019). All but one study that use no-action frames use it for the loss frame, not the gain frame.

Looking at the evidence, an interesting pattern emerges. Loss framing shows to be disproportionately more effective in the action frames – 71%, compared to 43% when the avoidance frames are used. Gain framing, too, seemed to be more effective when the messages called to action, though since there was only one study using inaction in the gain frame (showing it to be ineffective) conclusions cannot be drawn.

Overall, then, appeals that call to- or describe the consequences of action are more successful. This offers support for the action bias hypothesis, which postulates that action is considered to have an impact by itself (Patt and Zeckhauser, 2000). Correspondingly, it provides counter-evidence for omission bias (Ritov and Baron, 1992), according to which people are more averse to damaging action than to equally damaging inaction (or omission). Insofar as omission bias is one of the two components of the status quo bias (Schweitzer, 1994), the evidence here seems to be at odds with this particular manifestation of loss aversion. On the other hand, this result seems to suggest linguistic variation is enough to lead subjects to make a more environmentally-friendly decision; behavioural changes that affect them are not necessary.

However, as Levin et al. (1998) warn, as the action-avoidance categorisation employs different terminologies, it may be difficult to separate the effect of negativity bias and emotional intensity associated with the language used, and so one must be cautious when interpreting its effects.

2.2.6 Implications of the systematic literature review

This review has provided an inventory and characterisation of the current state of the framing movement, which may serve both as a knowledge base for future researchers to build on, as well as guidelines for policy makers and practitioners. The evidence gathered provides support for the loss aversion component of prospect theory, as conceived by Kahneman and Tversky (1979). The studies analysed show that framing a consequence of an environmentally-relevant decision as a loss that must be prevented is more likely to lead to behavioural change than framing it as a gain to be achieved in the case of pro-environmental behaviour.

Importantly, whilst gain framing has also been shown to be effective in certain contexts, it did not lead to changes in conduct, but only ever to changes in stated preferences. The measurement of preferences is valuable for better understanding the prevailing sentiment among the population. Insofar as preferences lead to action, stated preferences represent a useful mechanism for both understanding and influencing behaviour – either of the individual directly or of others through social norms and awareness spreading.

Yet, the potential for preferences as levers of change may be limited: as previous research has shown, in the environmental domain and elsewhere, beliefs, attitudes and intentions are not being translated into behaviour (Blake, 1999; Boulstridge et al., 2000). In the studies captured here, too, even though gain frames were in fact better at improving environmental attitudes, loss frames were more effective in changing behaviour (albeit based on a small sample of studies) and intentions. Even more, where both stated preference and behaviour were measured within the same experiment, gain framing successfully shifted preferences, but loss framing changed behaviour (Lord, 1994; Nabi et al., 2018). As discussed in section 2.1.9, within environmental psychology, this discrepancy has sought to be explained by infrastructural and other external barriers, competing intrinsic values, and measurement issues (Rajecki, 1982; Kollmuss and Agyeman, 2002). Economists, on the other hand, argue that the

hypothetical bias stems from a lack of incentive compatibility and consequentialism in stated preference studies (Carson and Groves, 2007).

A third explanation sees behaviour as a result of heuristics in judgment and decision making, justifying an absence of conformity with stated preferences. Heuristic processing may be deliberate and rational, trading accuracy of outcome for lower time and effort of decision making (Payne et al., 1993; Gigerenzer and Gaissmaier, 2011). Alternatively, it may be an automatic operation – as stipulated within behavioural economics – leading to subconscious cognitive biases (Tversky and Kahneman, 1974). In terms of the latter, in line with the dual process theory terminology (Wason and Evans, 1974), framing can be considered a type 1 (or 'pure') nudge as it addresses automatic thought processes and leads to subconscious behaviour (Hansen and Jespersen, 2013), providing theoretical support for leveraging the loss aversion bias through message framing. This stipulation will be further investigated in the thesis' empirical study (chapters 3 and 4).

Table 5: Goal framing typology

Goal framing typology	Brief description	Example - loss frame	Example - corresponding gain frame	Frequency	Loss frame effective[1]- (av. = 70%)	*Only* loss frame effective -(av. = 49%)
Cause frame	Change to environment following an action	*"Will bad"*: "[...] Without change, a broad range of environmental problems, including garbage and pollution, will continue to grow. The result? Quality of life will diminish [...]" (Davis, 1995, p. 289)	"*Will-good"*: "[...] With change, a broad range of environmental problems, including garbage and pollution, can be resolved. The result? Quality of life will improve [...] " (Davis, 1995, p. 289)	46	78%	50%
			"Won't bad": ˇ"[...] Air pollution mitigation prevents weakening of the plants, emergence of pests and diseases such as dried spots on the leaves, plant growth reduction and yield loss" (Mir et al., 2016, p. 335)	6	17%	17%
Prevention frame	*Prevention* of change to environment following an action	*"Won't good":* "... by not recycling, reusing, reducing and conserving energy, you fail to preserve the health of your planet [...]" (Kim and Kim, 2014, p. 73)	*"Will good":* "... by recycling, reusing, reducing and conserving energy, you are working to preserve the health of your planet [...]" (Kim and Kim, 2014, p. 73)	3	33%	33%
			"Won't bad" - not used in studies reviewed.	0	/	/
		"Won't bad" [2]: "It is important to use energy efficient CFL bulbs because I don't want to waste energy" (Craig and Allen, 2014, p. 227)	"*Will good*" - "If I use energy efficient CFL bulbs, I can help save energy." (Craig and Allen, 2014, p.227)	6	83%	83%
Action frame	Positive consequences from carrying out the action	"So, if you choose to buy the first version of batteries, that is, the ones that are polluting, instead of the second version, you will deeply contribute to the destruction of the environment and to the bad living conditions of future generation" Amatulli et al. (2019, p. 1128)	"So if you choose to buy the second version of batteries, that is, the ones that are not polluting, instead of the first version, you will help the environment and concretely contribute to the well- being of future generations." Amatulli et al. (2019, p. 1128)	23 [3]	79%	71%
			Avoidance: describes benefits if the hotel room linen is not changed frequently (Hu et al., 2018, p. 195)	1	100%	100%
Avoidance frame	Positive consequences from *not* carrying out the action	"Without mitigating climate change, we will see further increases in winter floods in maritime regions and flash floods throughout Europe." (Spence and Pidgeon 2010, p. 46)	*Action:* "By mitigating climate change, we can prevent further increases in winter floods in maritime regions and flash floods throughout Europe." (Spence and Pidgeon, 2010, p. 46)	28 [3]	68%	43%

Note: 1 Captures studies where loss frame was more effective and equally effective (depending on moderator or without); 2 Studies classify »won't bad« frame under the loss category; 3 Not specified or discernible in 9 studies

Source: author's own

2.3 Pro-environmental behaviour in tourism

The behaviour under empirical examination in this thesis is voluntary carbon offsetting for air travel. Before presenting the motivation for studying this type of behaviour, together with an in-depth review of the state of the art and literature (chapter 2.4), I briefly introduce its wider social, political and economic context: tourism. Tourism and travel are indistinctly intertwined: according to the UN Statistical Commission, air travel is simultaneously a hyponym (subtype or subset) and hypernym (umbrella term) of tourism (UNWTO, 2010, p. 10 and 55). Specifically for my study, however, since I filtered-in individuals who travelled for leisure (and not employment or study – see chapter 3.3), I should have captured only tourists, not other travellers. By consequence, for the purpose of this thesis, air travel is categorised under tourism. This thesis similarly takes a narrower view of air travellers: otherwise defined as anyone who "moves between different geographic locations for any purpose and any duration" (UNWTO, 2010, p. 9), an air traveller travelling for leisure only is considered a tourist (indeed, he or she is a particular type of tourist that travels for leisure)[9]. Finally, just as tourists are consumers of tourism experiences (Goodwin and Francis, 2003), air travellers can also be considered consumers of air travel. As such, they represent one of the largest potential consumer bases for the purchase of voluntary carbon offsets.

Tourism has a complex relationship with the natural environment. It both importantly contributes to- and is in many ways affected by climate change. Its negative implications for environmental sustainability, however, go beyond greenhouse gas emissions to include impacts on land, forestry, biodiversity and water, to name a few. This represents the backdrop for the practical motivation for this thesis and is introduced in section 2.3.1. The next section defines and delineates pro-environmental behaviour in tourism and discusses some recent trends. Finally, I present an overview of the empirical work on pro-environmental behaviour in tourism research, focusing on the work that is methodologically and theoretically comparable to the main study of this thesis. A review of empirical literature in air travel research specifically is presented in chapter 2.4.

2.3.1 Tourism and the environment

It has been estimated that the tourism industry accounts for a troubling 8% of global greenhouse gas emissions (Lenzen et al., 2018). This includes the CO_2 and CO_2-equivalent emitted from engaging in tourism activities and carbon embodied in the goods and services purchased by tourists (accommodation, food, shopping), as well as supply chain emissions for those activities, goods and services. The figure was calculated for 2013 and represents an increase from 3.9 to 4.5 $GtCO_2e$ (+14%) since 2009. Air travel emissions, for instance, account for 20% of global greenhouse gas emissions. The authors additionally predict that tourism-related emissions will increase to 5 $GtCO_2e$ in the conservative and 6.5 $GtCO_2e$ in the pessimistic scenario (Lenzen et al., 2018), representing an 11-44% increase. The estimates were calculated before the Covid-19 outbreak and accompanying travel restrictions, which led to a global drop in export revenues from tourism of $1 trillion (-63% from €1.7 trillion) and a

[9] For the purpose of this discussion, I also make the assumption that individuals that travel by air for leisure stay at their destination overnight; otherwise, they would be same-day visitors, not tourists.

$1.9 trillion contraction in the economic contribution of tourism (-54% from $3.5 trillion) (UNWTO, 2021). However, key tourism performance indicators already rebounded sharply in 2021 and the first months of 2022 (the latter +182% year-on-year), though still haven't reached pre-pandemic levels (UNWTO, 2022). Without corresponding carbon efficiency improvements, tourism growth in the future may be mirrored in growth in CO_2 emissions from the sector. For its part, the tourism sector has set itself a 'net-zero' commitment by 2050, as per the 2021 Glasgow Declaration (One Planet, 2015); in other words, signatory states aim to make their tourism sector climate neutral by 2050.

Bringing emissions to net-zero in a period of tourism growth will require bold actions by all tourism stakeholders. Reducing climate change impacts, however, is only one of the response requirements; the tourism sector will also have to adapt to changes in the climate. Climate change is already impacting both tourism demand and tourism supply, the latter encompassing investments, planning and operations (WTTC, 2021). To reduce the burden of the manifestations of climate change on environmental, social and economic systems, adaptation strategies are needed; despite this, existing research has largely focused on climate change impacts on destinations rather than adaptation strategies (Scott and Gossling, 2022).

Negative impacts of tourism on the environment are not confined to greenhouse gas emissions. They also include loss of biodiversity, generation of solid waste and sewage, and consumption (and risk of depletion) of key natural resources – water, land, energy and materials (UNEP, n.d).

2.3.2 Concepts and trends in environmentally sustainable tourism

A number of different concepts have been employed in the literature to designate conduct that minimises negative impact on the natural environment: environmentally sustainable- (e.g. Ballantyne et al., 2011; Verfuerth et al., 2019), ecologically sustainable- (e.g. Lim and McAleer, 2005; Hedlund, 2011) or simply sustainable behaviour (Passafaro, 2020; MacInnes et al., 2021); green behaviour (Line et al., 2018; Thøgersen and Noblet, 2012); environmentally responsible behaviour (Chiu et al., 2014; Lee et al., 2013); environmentally-friendly- (Dolnicar et al., 2017; Hergesell and Dickinger, 2013), or eco-friendly behaviour (Baker et al., 2014; Kvasova, 2015;); environmentally conservative behaviour (Wang et al., 2020); and environmentally significant behaviour (Kaklamanou et al., 2013; Stern, 2000).

Although a number of (also recent) studies use 'sustainable tourist behaviour' to mean *environmentally* sustainable behaviour of tourists (e.g. Leon and Arana, 2020), environmental sustainability is just one of the three pillars of sustainable tourism, together with economic and socio-cultural sustainability (UNWTO, n.d.). Importantly, the long-term sustainability of tourism depends on a balance between the environmental sustainability pillar and the socio-cultural and economic pillars, while maintaining high levels of tourist satisfaction, UNWTO (n.d) asserts. Environmental sustainability, for its part, refers to acting and living within the limits allowed by natural resources, in a way that ensures future generations can also meet their own needs (Goodland, 1995). Included indicators pertain to risks of deforestation and biodiversity loss, energy efficiency, and CO_2 emissions, as well as to access to safe drinking water, sanitation and secure dwelling (UN, 2001). Though some authors are already advancing the concept of environmental sustainability to include socio-cultural and economic

environments in the identification of tourism's environmental impacts (Mihalic and Fennel, 2015; Mihalic and Kaspar, 1996), this dissertation takes a more conservative approach. Namely, it leans on the UNWTO definition of sustainable tourism ("tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities" – UNWTO, n.d.), according to which environmental impacts are distinct from economic and social impacts.

In terms of outgoing tourism, a component often overlooked are the justice and equity implications of tourism and travel. Namely, the enjoyment of tourism experiences is unevenly distributed across the globe, dividing citizens into the excess and the deprived (Mihalic and Fennel, 2015). This violates the Global Code of Ethics for Tourism (UNWTO, 2012), which declares access to tourism to constitute a right that should be equally and without discrimination enjoyed by all global citizens (Articles 7 and 8). Though the issue is wider, its implication for the uneven consumption of environmental resources in the scope of tourism activity is of particular relevance for this dissertation. In other words, there exists inequality in the burden of responsibility for tourism's negative impact on the environment across the world. Pressures to mitigate the environmental impact of tourism and travel through reducing their future growth could, then, also be seen as a threat to the right to travel (Mihalic and Fennel, 2015). To mitigate this threat, the authors argue, rather than reducing travel, governments should introduce certificates – for tourism activity in general as well as for the use of environmental resources and emitted pollution. Voluntary carbon offsetting for air travel can be seen as one of these mechanisms (see chapter 2.4) – though, as per Mihalic and Fennel (2015), these only serve to mitgiate the unequal distribution of the consumption of environmental resources and not of the consumption of tourism activity in general.

Sustainable tourism research started with conceptualisations and theoretical discussions, which moved way for empirical studies that test and analyse specific ideas (Bramwell et al., 2016). For a long time, the dominant paradigm has been to explore attitudes and behaviours of individual actors (Bramwell et al., 2016). Taking as an indicator the number of articles published in Journal of Sustainable Tourism, the journal dedicated to tourism sustainability research, we can see that the vast majority of research relates to consumption patterns (Sustainable development goal n.12), which involve individual behaviour and opportunities for behavioural change (ibid.). To this end, the concept of environmentally sustainable behaviour was employed to represent an individual tourist's conduct (e.g. Juvan and Dolnicar, 2014) rather than decisions from other stakeholders, such as destinations or the tourism industry, moulding slightly the concept of environmental sustainability to fit individual research questions. Some researchers (Hall, 2016; Williams, 2013) underlined the importance of studying instead how decisions on individual behaviour are imbedded in wider socio-technical structures and social relations. These include our consumption systems, together with social norms through which they are reinforced, and production systems, sustained through infrastructure, technology and governance structures (Bramwell et al., 2016).

Scholars additionally warn that sustainability is too often confined to theory (Buckley, 2012). To distinguish between sustainability as a concept and as action, responsible tourism as "tourism that realises the concept of sustainability" (Mihalic, 2020, p. 5) gained prominence (e.g. European Commission, 2012; UNWTO, 2012). Recognising the importance of both the

concept of sustainability for tourism and its implementation, the term 'responsustable' was conceptualised to encompass tourism that is both sustainable and responsible (Mihalic, 2016).

A number of other trends are worth mentioning. First, tourism research also follows the general trend witnessed in social sciences in taking a critical view of the existent modes of thinking and practices in our society (Costa and Ribeiro, 2019). This 'critical turn' in sustainable tourism literature involves topics such as sources of inequality, power relationships, alienation and the cultural specificity of knowledge (Bramwell and Lane, 2014). As Dwyer (2018, p. 29) argues, this "'business as usual' seems impossible to reconcile with sustainability". There is also growing momentum in academic research to evidence wider social and economic impact, with tourism and travel research no exception (Jones and Walmsley, 2021). More and more weight is being placed on the applied value of research, for which engagement with stakeholders from business is crucial (ibid.). This is also related to the next trend: methodological push towards real behaviour analysis, especially through field experiments. In Bramwell et al's (2016) review, the vast majority of studies were done based on secondary data analysis, qualitative interviews or quantitative surveys, not experiments. Since then, the experimental methodology has gained traction, though still represents the minority of empirical research and calls for wider use remain (Viglia and Dolnicar, 2020).

Finally, due to the momentous effects of the Covid-19 pandemic and accompanying travel- and hospitality restrictions on global tourism, tourism literature has since 2020 been dominated by research into the effects of the pandemic (Kim et al., 2021; Okafor and Yan, 2022) and destination resilience (Kim et al., 2021) as well as post-Covid technological trends, such as service innovation (Mu et al., 2022) and virtual tourism (Zheng et al., 2022). At least in the most prestigious general tourism journals, environmental sustainability has been pushed to the sidelines or studied through the 'Covid-19' lens (Higgins-Desbiolles, 2020; Tauber and Bausch, 2022). Nevertheless, it is an important topic and is bound to return to the forefront due to the long-term and unavoidable nature of the threat of climate change to all aspects of our economy and livelihoods.

A single PhD thesis would not be able to do sustainable tourism justice. Even within the environmental sustainability pillar and, more specifically, category of empirical work investigating individual behaviour, further focus is warranted. This is because predictors of behaviour and the corresponding interventions aimed at inducing it are considered to be specific to each type of pro-environmental behaviour (Miller et al., 2015; Steg and Vlek, 2009). The pro-environmental behaviour in focus here is offsetting air travel (see chapter 2.4). Other types of pro-environmental behaviour in tourism studied elsewhere are reviewed in section 2.3.3 below.

2.3.3 Studies on pro-environmental behaviour in tourism

Research into pro-environmental behaviour in tourism can be broadly divided into the conceptual and the empirical[10]. The former includes reviews (e.g. Bramwell, 2016; Passafaro, 2020) and theory-building (Mihalic, 2020). Empirical research can be divided according to the type of behaviour investigated, the underlying theory or the method used.

[10] This broad categorisation includes full papers as well as research notes, commentaries and letters

In terms of behaviour type, pro-environmental behaviour investigated in the tourism and travel context includes recycling (Aguiar-Castillo et al., 2019); reducing food waste (Papargyropoulous et al., 2016; Pirani and Arafat, 2016); picking up litter (Brown et al., 2010); reducing water use in hotels (Casado-Diaz et al., 2022); choosing environmentally-friendly transport modes (Prillwitz and Barr 2011; Hergesell and Dickinger 2013) and offsetting one's travel (Brouwer et al., 2008; Gossling et al., 2007); staying in eco-certified accommodation (Fairweather et al., 2005); purchasing eco-certified products (Karlsson and Dolnicar, 2016); engaging in environmentally sustainable activities while on holiday (Han and Hyun, 2017); and supporting conservation (Ballantyne et al 2009; Chen et al., 2017).

Tourism studies follow other environmental psychology research in their treatment of pro-environmental decisions – i.e. stated preferences and genuine behaviour (see chapters 2.1.8 and 2.1.9). Namely, most of the work leans on the theory of planned behaviour, which sees behaviour as an outcome of conscious and deliberate choices that reflect attitudes, an approach this thesis departs from. In reality, attitudes and behaviour have been shown to diverge, a gap that is exacerbated in the tourism context (Barr et al., 2010). Reasons for this range from absence of appropriate infrastructure (Wu et al., 2021) and different systems, norms and regulations abroad than at home (Juvan and Dolnicar, 2013), to habits (Miller et al., 2015), and justifications related to the subjective hedonic experience of travel (Juvan and Dolnicar, 2014). In terms of the latter, it has been argued that the search for short-term pleasurable experiences that lie at the heart of tourism stands in contrast to pro-environmental behaviour, which often carries pecuniary, temporal or effort costs (Dolnicar et al., 2017). Most empirical research in this context measures stated preferences rather than actual behaviour. These include attitudes (see Passafaro, 2020, for a review), intentions (e.g. Tonge et al., 2015; Clark et al., 2019) and willingness to pay (e.g. Ritchie et al., 2021; Rotaris et al., 2020).

A few studies, by contrast, draw on insights from behavioural economics. As discussed at length in chapter 2.1, behavioural environmental economic research concerns itself with cognitive biases that hinder or encourage pro-environmental behaviour (among other research topics – see chapter 2.1.4). The discipline goes hand in hand with experimental economics, leaning on experimental methods and the measurement of real behaviour. For tourism studies, this most often involves experimentally testing various green nudges.

The theoretical concept of loss aversion has been empirically investigated either implicitly or explicitly through loss framing of environmental appeals and changes to the default setting. As per the former, Grazzini et al. (2018) found messages that are loss-framed and concrete to be the most effective for encouraging hotel guests to recycle. Leveraging the default bias by making the pre-assigned setting the pro-environmental option has been shown to successfully nudge reductions in daily room cleaning in hotels (Knezevic Cvelbar et al., 2021), the use of less CO_2 intensive recycled paper serviettes in place of cotton ones (Dolnicar et al., 2018), tourists' support for climate change policy (Arana et al., 2012), and the purchase of voluntary carbon offsets (Arana and Leon, 2012).

Other nudges that have been tested in tourism research include appeals to social norms, commitment devices, changes to the physical environment, provision, simplification or

redesign of information, and reminders. In a seminal experimental study on social norms, Goldstein et al. (2008) found that informing hotel guests how many other guests reuse hotel towels increases towel reuse by up to 14%. A similar finding was reported by Reese et al. (2013) who investigated the additional effect of appealing to provincial norms compared to the standard environmental appeal. Building on previous work on self-signalling and the consistency bias, Baca-Motes et al. (2013) successfully tested a commitment device. They showed that hotel guests that committed to practicing pro-environmental behaviour beforehand were 25% more likely to do so – here, to reuse their towels at least once during their stay. Towel reuse rates were also found to increase following the introduction of environmental information (Mair and Bergin-Seers, 2010) or improvement of its wording (Gossling et al., 2019). Finally, in terms of changes to the physical environment, Kallbekken and Saelen (2013) showed a simple reduction in the size of hotel buffet plates can reduce food waste by 22%.

More conventional economic interventions encompass financial incentives for pro-environmental behaviour. Dolnicar et al. (2017), for instance, found that incentives in the form of vouchers for free drinks had a positive effect on hotel guests' room requests. Line et al. (2017) investigated the effect of four different types of incentive and how they interact with a destination's image (urban or nature-based). They showed that financial incentives ($5 credit to spend in the hotel's restaurant) did not matter for nature-based tourists, but improved visitors' willingness to participate in a hotel's sustainability program in urban destinations.

2.4 Voluntary carbon offsets

I focus on a particular type of environmentally-relevant behaviour in travel and tourism: air travel. The following section explains the motivation for selecting voluntary carbon offsets as the target behaviour for intervention within this thesis.

I start by presenting the practical motivation for studying voluntary carbon offsets: aviation's contribution to climate change, which is expected to grow quicker than fuel efficiency and which therefore necessitates individual action – either in the form of reducing air travel altogether or by reducing the net impact of flights on the environment through offsetting. Whilst foregoing a flight may bring the highest benefit to the environment, it is fraught with ethical dilemmas and implementation challenges. Air travel represents a large share of tourism's contribution to climate change, presenting a challenge to the "future credibility of the concept of sustainable tourism" (Gossling et al., 2017, p. 3). However, it is also the backbone of the tourism industry, especially for countries reliant on international arrivals. I follow the chapter by introducing a different option: voluntary carbon offsets. After providing a brief overview of carbon offsetting, I focus on the voluntary market and its scope and benefits, as well as some criticism voluntary carbon offsets have faced and challenges they still need to overcome, including low participation rates.

The section continues with a review of the empirical evidence. A number of scientific studies in the last 15 years have sought to better understand why people do or do not purchase voluntary carbon offsets, and identify measures that will lead to higher participation rates. The search to disentangle the theoretical reasons for low adoption rates across disciplines and

proposal of a new measure, grounded in behavioural economics, represents the theoretical motivation for studying voluntary carbon offsets in my thesis.

2.4.1 Air travel's impact on the environment

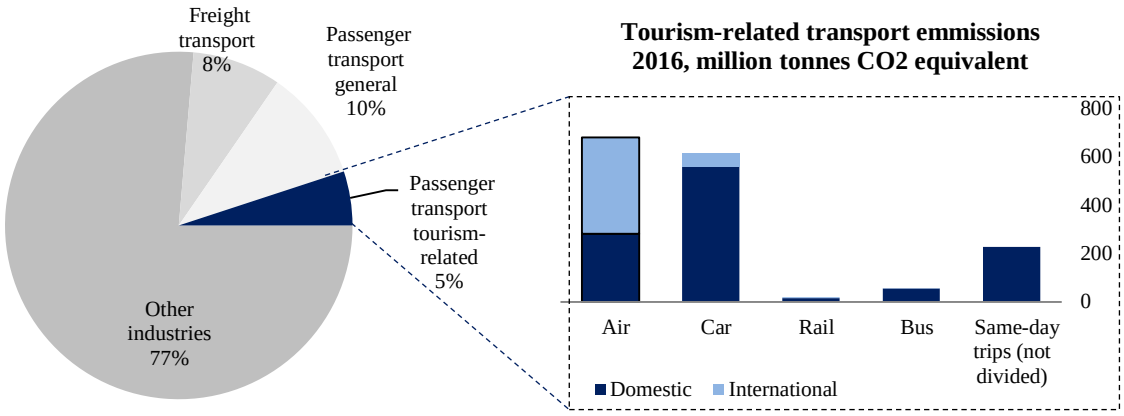
Air transport is an important contributor to global greenhouse gas emissions and, with this, to climate change: aviation emissions represent approximately 50% of transport-related tourism emissions of CO_2 (both international and domestic) and 11% of all transport emissions, as illustrated in Figure 8 (UNWTO-ITF, 2019). Its total contribution to global carbon emissions is estimated at between 2% (UNWTO-ITF, 2019) and 3.5% (Lee et al., 2021). Aircraft emissions are particularly harmful because they include nitrogen oxides, sulphates and black soot, which have a stronger (albeit transient) global warming effect (Grewe et al., 2017). Their contribution to global warming may therefore be 2 to 3 times greater than their impact attributed to carbon emissions alone (Transport and Environment, 2018).

The Covid-19 pandemic and accompanying restrictions on travel have led to a drop in air transport, temporarily reducing global CO_2 emissions in 2020 (Le Quere et al., 2020). The International Air Transport Associated predicts the growth in passenger journeys will recover to 2019 levels by 2024 in most of the world (IATA, 2020). Looking forward, passenger growth between 2019 and 2040 is forecasted at 1.5%-3.8% annually (ibid.), and the accompanying CO_2 at an alarming 300% by 2050 (Higham et al., 2018), despite the drop in 2020-21 (Ritchie et al., 2021).

The air industry will take an increasing share of national carbon footprints and carbon budgets, necessitating either cutbacks, drastic improvement in efficiency of modern aircraft, or decarbonisation in other industries (Turner et al., 2009), which may further lead to conflict between different sectors of the economy and/or government. Fuel efficiency has already been improving: it is estimated to have grown by 1.5% annually between 1960 and 2008 (OECD-ITF 2012) and is forecasted to grow further at 2% per year (ICAO, 2019a), owing in particular to its financial incentive for airlines themselves. However, even the ICAO (ibid.) considers their own prediction to be an "aspirational goal" and yet, at the same time, insufficient to meet future demand. The contribution of the aviation industry to global greenhouse gas emissions will therefore only continue to grow.

At the same time, air travel is likely one of the single largest one-off contributor's to an individual's carbon footprint. Not only are single trips on average longer, but global greenhouse gas emissions per passenger kilometre are also much higher than through other means of transport – by plane it is 170 gCO_2eq compared to 50 gCO_2eq by car (Kamb and Larsson, 2019). Mitigating the impact of air travel on the environment therefore represents one of the biggest opportunities for an individual's CO_2 reduction. With 12.3 million individuals flying daily in pre-pandemic times (ICAO, 2019b), individual behavioural change can add up to huge global impact.

Figure 8: Man-made CO_2 emissions



Source: author's own, based on data from UNWTO-ITF (2019)

Yet, for an individual, foregoing a flight is also a big sacrifice: for many travellers, there are no alternative means of transport connecting to their destination, so a flight foregone means a vacation foregone. With the tourism industry contributing 10.4% to the global economy and 10% to employment before the Covid-19 pandemic (WTTC, 2019), banishing all flights is neither economically nor socially sustainable, particularly for economies dependent on tourism inflow. Air travel is also important from a sociological and socio-psychological perspective (Tyers, 2016): it is considered an aspirational activity, carrying economic and cultural capital; in the face of globalisation and international migration, it is necessary for the maintenance of familial ties; it is connected to the preservation of one's own identity; and flying has become ingrained in social practices. Finally, as mentioned in chapter 2.3.2, since citizens of different countries and incomes have unequal access to tourism experiences, seeking to reduce air travel may also have negative global justice implications.

Where more environmentally-friendly transport options are not feasible, air travellers can mitigate their contribution to climate change by purchasing carbon offsets for their flight. It is this option – this form of environmentally-friendly behaviour – that is the focus of the thesis and will be described in more detail below and empirically investigated in the following chapters.

2.4.2 Definition and scope of voluntary carbon offsets

Carbon offsets are reductions in the emission of carbon dioxide or other greenhouse gasses into the atmosphere, made in order to compensate CO_2 emitted elsewhere (Carbon Offset Guide, n.d.). Carbon offsetting can take place either on the compliance market or on the voluntary market. Compliance markets were initiated by the Kyoto Protocol's Clean Development Mechanism and can be divided into project-based transaction systems and allowance-based transaction systems (Bayon et al., 2007). The latter includes emission trading schemes (such as the EU Emission Trading Scheme), which involve legally binding caps on annual carbon dioxide emissions, beyond which companies, governments or other entities need to buy carbon offsets. The compliance carbon market was worth €238 billion in 2020, a 23% increase from the year before and a five-fold increase from 2017 (Refinitiv, 2021).

Payments can also be made by companies, non-governmental organisations or individuals voluntarily. Voluntary carbon offsets are newer (gaining ground in 2005) and smaller in terms of market size, with an estimated 188 million tonnes of carbon dioxide equivalent ($MtCO_2e$) being traded through voluntary programmes in 2020, worth approximately $473 million (Forest Trends Association, 2021). Volume traded in 2020 was an impressive 80% higher than the year before, with 2019 itself being a growth year (ibid). With a growing sense of environmental responsibility among individuals, an increased importance of corporate social responsibility for a company's revenue, and ambitious climate policy targets, their significance and contribution can be expected to continue to grow rapidly. Indeed, it is estimated that annual global demand will increase to up to 13 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) by 2050, potentially worth as much as $50 billion, depending on pricing and drivers (Blaufelder et al., 2021).

Since voluntary markets are not regulated, their supply chain is more fragmented, with a number of verifiers, retailers, brokers and other intermediaries participating in the market, connecting the project suppliers (developers) and the consumers (individuals and institutions) (Bayon et al., 2007). Middlemen can be profit or not-for-profit organisations, whilst consumers can be both individuals and institutions, the latter further divided into the private-, public- and social sector. Taking the perspective of an individual, voluntary carbon offsets can be purchased from airlines directly or from non-governmental organisations (MyClimate, Atmosfair, Native energy etc.), which provide CO_2 calculations for flights, other activity or annual carbon footprints, as well as the possibility to donate a discretionary amount.

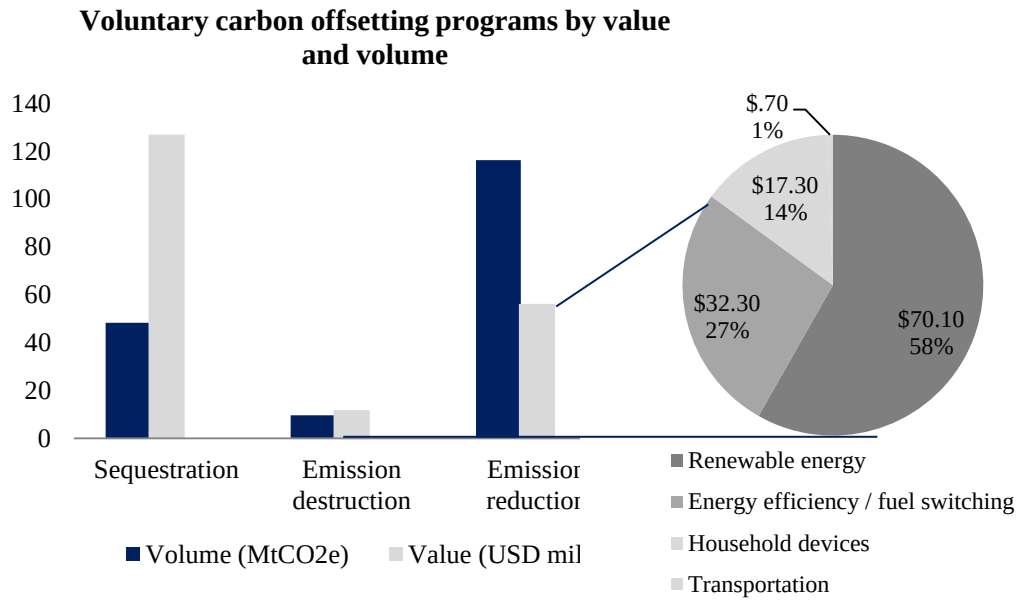
Voluntary carbon offsetting programs can be divided into three broad categories: emissions destruction, emissions reduction and sequestration programs (Bayon et al., 2007, p. 113).

Emissions reduction projects include energy efficiency improvements, fuel switches, power plant upgrades, and investments into renewable energy. On the field, these projects may involve donating energy efficient cooking stoves to poor households in Darfur, building small-scale wind farms in India, or training villagers in Vietnam on how to build and maintain biogas digesters (Ecoact, n.d.). Renewable energy and energy efficiency projects are the most common initiatives offered by airlines to their customers (Guix et al., 2022). In 2020, emissions reduction projects reduced 115.2 $MtCO_2e$ globally, representing 66% of the voluntary carbon market size and 28.6% of its value (Forest Trends Association, 2021). Of this, 70% can be attributed to renewable energy projects (see Figure 9).

Emissions destruction primarily involves methane abatement (capture and flare from landfills, livestock manure pools and coal mines), but can also include trifluoromethane and nitrous oxide gas destruction. Chemical processes, such as carbon capture and storage, also belong to this group.

Sequestration projects avoid the release of CO_2 into the atmosphere or pull out CO_2 from the air. The Reduced Emissions from Deforestation and Degradation (REDD) programme and other land use programmes were worth $269 in 2020, representing more than half of the voluntary carbon offset market in value (Forest Trends Association, 2021).

Figure 9: Voluntary carbon offsetting programs by value (USD) and volume (MtCO2e)



Source: author's own, based on data from Refinitiv (2021)

2.4.3 Benefits and challenges of voluntary carbon offsets

The main strength of carbon offsets and, indeed, their raison d'être is the benefit to the environment – the reduction in global net carbon dioxide (or equivalent) emissions.

Environmental co-benefits include reduction in air- and water pollutants (particularly within energy efficiency programs), as well as safeguarding bio-diversity and erosion protection in sequestration, reforestation and afforestation projects. Since the majority of projects take place in developing countries, many also deliver a so-called "development dividend", with the communities involved benefitting from improved health and support to human development (Taiyab, 2005), increased climate change awareness, new job opportunities, technological innovation and progress (Gillenwater et al., 2007), and/or national security thanks to lower dependency on fossil fuels (Hooper et al., 2013, p. 18).

Voluntary carbon offsets have, however, been the subject of some criticism, directed both at their implementation as well as their very existence.

Voluntary offsetting has been referred to as a way to maintain current patterns of mobility (Gossling et al., 2007), whilst alleviating guilt. This may lead to negative spillovers such as rebound effects and moral licensing, which reduce the estimated positive impact of voluntary carbon offsets on the environment. The former may see individuals choosing to fly *more* following the option to offset their flights, since now they do not have to feel guilty for doing so. Meanwhile, moral licensing – defined as a psychological mechanism individuals use to free themselves from moral behaviour in one domain following good behaviour in another domain (Merritt et al., 2010) – may lead to a reduction in pro-environmental behaviour elsewhere. Finally, being aimed at reducing carbon dioxide and CO_2-equivalent emissions by design, they do not address all climate change impacts, such as those on water and

biodiversity (Hooper et al., 2013), though some individual projects do have those co-benefits, as discussed above.

Airlines offering voluntary carbon offsets have been accused of "greenwashing" (Polonsky et al., 2010): the use of this offer by companies to promote themselves as being carbon neutral in their activities, even though the firm has not reduced its carbon output (it has merely offset it), nor are its entire operations carbon neutral, only flights taken by the passenger.

There are also a number of controversies surrounding the implementation of voluntary carbon offset projects, including leakage (defined as "emissions reductions within a project area [that] are counterbalanced by increases outside it", MacKerron et al., 2009, p. 1373); diminishing long-term effects; poor project permanence, with CO_2 emissions only delayed until a future date; and double counting (ibid.).

To address these challenges and concerns from buyers of offsets, a number of verification schemes have been formed. Credit verification considerations include project permanence and additionality (necessitating CO_2 reduction over and above any business-as-usual savings), prevention of leakage and double-counting, ex-ante and ex-post accounting, as well as the potential for co-benefits (Bayon et al., 2007).

A final and arguably most important challenge we are witnessing when it comes to voluntary carbon offsets – one not unrelated to the issues listed above – is low participation rates: only 1-3% passengers, on average, purchase an offset for their flight (Aviationbenefits, 2020)[11]. From the supply side, 41 airlines offered voluntary carbon offsets in 2020 (Guix et al., 2022). The figure represents a net drop from 44 in 2016, with 10 new airlines offering customers the option to offset their flight, 3 airlines no longer operating or part of a merger, and 10 airlines no longer offer this option, perhaps due to the low demand.

The numerous challenges listed above, coupled with the fact that voluntary carbon offsetting depends on contributions which are both voluntary, unpredictable and irregular in nature as well as low in practice, leads many experts to conclude that voluntary carbon offsets are only the next best thing after mandatory instruments targeted at airlines (Eijgelaar, 2011; Gossling et al., 2007). Yet with high carbon emissions reduction targets and insufficient policy requirements to achieve them all, voluntary contributions are needed to mitigate air travel's negative impact on the environment. Short of reducing travel altogether, offsetting one's flight provides environmental and developmental benefits and should be encouraged. Whilst the low take-up represents a challenge, it also serves as an opportunity: with more room to improve and millions of air passengers travelling daily, a small percentage increase in the uptake can lead to important contributions to collective climate change mitigation. We turn to the reasons for low adoption rates explored in the literature (section 2.4.4), followed by potential measures researchers have tested to increase it (section 2.4.5).

[11] Refers to purchases made directly online through flight booking platform, thus excluding any purchases through third-party providers. Unfortunately, aggregate data is scant: a survey from 2011 (Mair, 2011) sees a high range of 1-10% of individuals purchasing a carbon offset, but with huge market growth since then, data from 10 years ago can no longer be considered reliable.

2.4.4 Factors related to purchasing a voluntary carbon offset

Various determinants of inclination to purchase a voluntary carbon offset have been identified in the literature and can be categorised as follows:

(i) Individual's socio-demographic characteristics
(ii) Individual's habits (flying and environment-related)
(iii) Individual's prior knowledge on the environment or on carbon offsetting
(iv) Individual's psychological factors, including norms and attitudes
(v) Trip characteristics
(vi) Project attributes
(vii) Price
(viii) Consumption context of offset purchase

The first five determinants are typically exogenous to a research model, whilst determinants (vi)-(viii) are endogenous and subject to manipulation within empirical (especially experimental) research. Interventions differ across disciplines, with project attributes being of particular interest to environmental psychologists, price to economists and the consumption context, or 'choice architecture' to behavioural economists. I will review each group in turn.

(i) Individual's socio-demographic characteristics

The vast majority of studies conducted through online or in-person surveys ask after the respondent's age, gender, education level and income, with additional occasional characteristics including family size, employment status, nationality and region of residence. More often than not, these socio-demographic variables do not have a statistically significant effect on outcome. The most commonly detected effects are from income, age and gender. Willingness to pay is found to decrease with age and increase with income (Blasch and Farsi, 2014; Lu and Shon, 2012; Schwirplies et al. 2019; Arana et al., 2012). Mair (2011) finds that purchase of a carbon offset is more likely among men than women, but Choi and Ritchie (2014) and MacKerron et al. (2009) compute a higher willingness to pay for voluntary carbon offsets among women. Women are also found to perceive offsetting messages as more credible than men (Zhang et al., 2019).

Europeans are more willing to offset than Asians (80% vs. 59%) according to the survey by Brouwer et al. (2008). This finding also matches the variation in willingness to pay between studies using samples from different countries - €1.20 average in Malaysia (Fatihah and Rahim, 2017) and €40 in, for instance, Spain (Arana et al., 2012), unsurprisingly reflecting purchasing power differences across the globe.

Finally, two studies find a statistically significant positive effect of education (Cheung et al., 2015; Mair 2011), and a single study identifies a statistically significant role of family size, namely that the number of children in the household negatively affects the propensity to offset (Loschel et al., 2013).

(ii) Individual's habits (flying and environment-related)

Flying frequency is positively associated with willingness to pay (Akter et al., 2009; Brouwer et al., 2008), but not universally so (Blasch and Farsi, 2014). Past purchase of carbon

offsetting was found to have a positive effect on perceived message credibility, which may in turn improve intentions to offset (Zhang et al., 2019, p. 11).

As per environmentally-relevant habits, Schwirplies et al. (2019) observe a positive relationship between identity with green politics and past donations to charity, and likelihood of offsetting. Somewhat surprisingly, no study has, to my knowledge, tested the potential effect of the participant's engagement in environmentally-friendly behaviour, his past financial contributions to an environmental organisation (rather than a charity in general) or membership in an environmental movement.

(iii) Individual's prior knowledge and beliefs about the environment or on carbon offsetting

Many studies identify beliefs to be important drivers of preferences: belief in the damage of CO_2 emissions from air travel is positively associated with willingness to compensate (van Birgelen et al., 2011), as is related knowledge (Lu and Wang, 2018). Choi and Ritchie (2014) also find a positive effect of perceived contribution of the individual's flight to climate change, but this effect was not found in Loschel et al. (2013). Belief in the effectiveness of global and national policies against climate change is influenced by knowledge on these policies and in turn affects willingness to offset (Ritchie et al., 2020), as does belief in carbon offset project efficacy in emission reduction (Lu and Shon, 2012). Van Birgelen and co-authors (2011) also detect a positive effect of beliefs about the importance of pro-environmental behaviour to society, though Choi and Ritchie (2014) find no evidence for the effect of environmentally-related beliefs from the New Environmental Paradigm (Dunlap et al., 2000) scale.

(iv) Individual's psychological factors, such as subjective norms and attitudes

A number of authors test how well the theory of planned behaviour (Ajzen, 1991) predicts offsetting preferences. As per theory prediction, intentions are driven by attitudes and personal norms, the latter both directly and through attitudes (Chen, 2013; Choi et al., 2016; Ritchie et al., 2020). Other antecedents of desires or attitudes are positive anticipated emotions (Chen, 2013), perceived behavioural control (Kim et al., 2015) and knowledge (Tao et al., 2021).

A single study measures the effect of norms on offsetting behaviour. In an economic experiment, Bauer and Menrad (2019) find that personal and social norms have a statistically significant effect on the likelihood that a participant donates a part of their study earnings to the Gold Standard carbon offsetting mechanism.

(v) Trip characteristics

Finally, type of trip may also influence the likelihood of purchasing a voluntary carbon offset: independent travellers may be more willing to offset (McLennan et al., 2014), as are travellers of domestic flights (Choi et al., 2018). As Brouwer et al. (2008) argue, since they often have a less-polluting alternative, domestic flights are associated with greater 'carbon guilt', leading to higher willingness to pay for carbon offsets. Whether a flight was intrinsically motivated (done for leisure) or extrinsically motivated (business trip) was not a significant determinant of willingness to pay (Schwirplies et al., 2019).

Schwirplies et al. (2019) explicitly examine the effect of the mode of transport, finding that the share of hypothetical offsetters is 11 percentage points lower for air- than for bus travel (63% and 74%, respectively). Average willingness to pay is also much lower for flights: €8 compared to €43 for bus trips.

2.4.5 Empirical review of explanations for offsetting behaviour

The determinants of carbon offsetting presented above are fixed for the purpose of the study and, though often asked after, external to the empirical work carried out. The exception to this are trip characteristics, which were manipulated within choice experiments; however, since they have no practical implication for change (an airline cannot, for instance, suddenly offer bus tickets), they were considered exogenous.

Below I present an overview of experimental studies on voluntary carbon offsets. The first section takes a consumer preference perspective, placing it in the environmental psychology literature. Studies examining the effect of project attributes are based on an underlying belief that individual preferences are both conscious and directly influence offsetting behaviour, leading to calls for intervention in this category. Ritchie et al. (2021, p. 2), for instance, argue that "understanding heterogeneity in consumer preferences for voluntary carbon offsetting schemes for specific travel contexts, therefore, is critically important to being able to develop offsetting schemes that are attractive to distinct subsets of air passengers." The (explicit or implicit) overarching theory here is Ajzen's (1991) theory of planned behaviour, which stipulates that attitudes impact intentions, which drive behaviour. Since behaviour is a function of intention, so the theory goes, examining the determinants of offsetting intentions should suffice as a proxy for behaviour. An interesting case-in-point is Denton et al.'s (2020, p. 1) study, which seeks to "Examine the gap between carbon offsetting attitudes and behaviors" (as per title), but actually explores the connection between attitudes and intentions, arguing that variables affecting a 'potential' gap between intentions and behaviour "are beyond the scope" of the paper.

That individuals have well-shaped and consequential preferences is also a tenet of the economics discipline. Since voluntary carbon offsets are an individual contribution to public goods, rational self-interested agents are predicted to free-ride and any deviations from no contribution would call for an explanation, rather than the opposite.

A behavioural economics perspective sees greater importance in the choice architecture, since actual purchase may not reflect the consumer's preferences. As discussed in chapter 2.1, individuals are prone to heuristics and biases and we can seek to either mitigate these or leverage them for socially beneficial goals. In the context of voluntary carbon offsetting, this may mean adapting the communication strategy, either by airlines offering the carbon offsets or by policy makers in wider education campaigns. An evaluation of the nudges carried out by researchers to increase the uptake in voluntary carbon offsets concludes this section.

(vi) Environmental psychology: project attributes

The majority of empirical work consists of manipulations to the description of projects benefiting from voluntary carbon offsetting. This encompasses project type, location, efficiency in reducing CO_2 emissions, certification and any co-benefits of the project. Whilst

preferences for the latter three are, where examined, uniform across different studies, project type and location effects are more ambiguous.

Rotaris et al. (2020) find that project type is one of the most important factors of willingness to pay, with reforestation earning the most; re-/afforestation projects were also preferred among participants in Schwirplies et al.'s (2019) and Blasch and Farsi's (2014) experiments. By contrast, willingness to pay was higher for renewable energy projects in the choice experiments conducted by Cheung et al. (2015), Choi and Ritchie (2014), and Choi et al. (2018). Choi and Ritchie (2014) also find that international projects garner a higher willingness to pay than domestic ones; Ritchie et al. (2021) and Hinnen et al. (2015) find the opposite to be the case.

Other project description attributes that were shown to have a positive statistically significant effect on willingness to pay are certification by governments (Blasch and Farsi, 2014), biodiversity and conservation co-benefits (MacKerron et al., 2009; Zhang et al., 2021) and higher effectiveness and management by non-profit organisations (Ritchie et al., 2021).

Finally, the length of the message may also be important. In a smaller psychophysiological experiment, Babakhani et al. (2017) observe that participants pay more attention to shorter descriptions of projects, suggesting that airlines should be more brief in their voluntary carbon offset messages (on the assumption that attention is sufficiently positively correlated with likelihood of selection). On the other hand, shorter messages are more likely to be misleading, as per Guix et al.'s (2022) framework for classifying airlines' messages on voluntary carbon offsets as trustworthy or misleading. This may be important since message credibility was found to influence purchase intentions (Zhang et al., 2019), yet only 56% of claims by airlines were found to be trustworthy (Guix et al., 2022).

Advocating for the necessity to tailor voluntary carbon offset appeals to individual customers based on their heterogeneous preferences, a number of studies divide individuals into profiles: Ritchie et al. (2021) form three customer segments around their reasons for purchase, Mair (2011) evenly splits her subjects according to their score on the New Environmental Paradigm scale, while McLennan et al. (2014) divide participants around a wider variety of socio-demographics and behaviour characteristics into "Repeat Asia-Pacific travellers", "Middle-aged leisure tourists" and "Young European Backpackers". The strength in these studies lies in laying the groundwork for a more targeted marketing strategy, coupled with their high sample sizes (998, 502 and 40000, respectively). However, they suffer from lack of realism: profiles are formed based on past reported behaviour and stated preferences, not actual behaviour. Therefore, whilst we have good knowledge on heterogeneity in preferences, we have limited knowledge on who can be swayed to purchase a voluntary carbon offset.

Indeed, the potential for hypothetical bias is a drawback of most studies in this section. As elsewhere (see chapter 2.1 for a discussion), voluntary carbon offsetting is also prone to attitude-behaviour gaps. Where experimenters measure both stated and revealed preferences, a clear divide emerges. Arana et al. (2012), for instance, compute the mean willingness to pay to be \$58 or \$95 in an online experiment (depending on treatment condition), whereas actual payment in a field experiment was \$21 and \$29, respectively. Looking at other environmental causes, Bouma and Koetse (2019) find hypothetical willingness to pay to be 3.5 times higher

than actual willingness to pay (i.e. payment), whilst Seip and Strand (1992) discover that only 6 of 64 subjects who stated a willingness to pay paid in the second round of the experiment. Studies examining preferences around carbon offsets show very high variability of willingness to pay, especially comparing revealed and stated preference experiments (Loschel et al., 2013). In a revealed preference study, median and mean willingness to pay for offsetting (non-behaviour specific) are €0 and €6, respectively (Diederich and Goeschl, 2011), whilst mean stated willingness to pay for offsetting car travel is an impressive-if-doubtful €256/tCO_2 (Achtnich, 2012).

It must, however, be acknowledged that while preferences cannot be used as indicators of behaviour, understanding consumers' motivations in itself is valuable, not least for policy makers seeking to gauge public opinion, and offset providers competing amongst each other to provide the most attractive project portfolio.

(vii) Economics: price and utility

One main variable of interest to economists is income, which should be and was indeed found to be positively related to payments (e.g. Blasch and Farsi, 2014; Schwirplies et al. 2019). As per standard economic theory, price has been found to have a negative relationship with demand, i.e. the propensity to offset (e.g. Loschel et al., 2013; Arana and Leon, 2012). Since the majority of studies measure willingness to pay as the dependent variable, price was not accounted for separately. Interestingly, a mandatory tax, which increases the total price, did not reduce the subjective value of voluntary carbon offsets, but increased it in Choi et al.'s (2018) study; rather than mandatory tax crowding-out voluntary contributions, the opposite crowding-in effect arose. It must be noted that they, too, ask after subjective valuation rather than actual payment, so hypothetical bias may occur. Similarly, almost as many respondents in a survey (Eslaminassab and Ehmer, 2021) said they would prefer carbon offsetting for flights to be mandatory – 42% vs. 45% who prefer voluntary payment, which goes against standard economic theory, which posits that additional choice is always an improvement of utility.

From an economics perspective, voluntary carbon offsets are an individual contribution to public goods, aimed at counterbalancing a 'public bad' (Blasch and Ohndorf, 2015, p. 251). This makes them subject to the free-rider problem, since benefitting is not dependent on the individual's contribution. However, people can be 'pure altruists' or 'impure altruists', deriving utility from the aggregate level of the public good (Bergstorm et al., 1986), or from their own contribution to the good, respectively (Andreoni, 1989).

Cost of transaction can also be incorporated into the utility framework. For an individual, it is effortful to navigate the voluntary carbon offsetting labyrinth and make sense of the high variability in the price of offsetting offered by different airlines and third-party providers. Indeed, the cost of offsetting can differ substantially depending on the provider, the location and the project chosen: for example, a passenger who wishes to offset his or her flight from London to New York, generating cc. 1 tonne of CO_2, will pay anywhere between €5 and €32 (United conservation, n.d.; Atmosfair, n.d.). Third-party providers' abundance of options may further lead to decision fatigue and lower likelihood of purchase, as stipulated by the paradox of choice (Schwartz, 2005). Buying an offset through a third-party provider also carries

(marginal but important) greater effort than simply selecting this add-on when booking a flight. This may be why 77% of respondents in a survey (Eslaminassab and Ehmer, 2021) said they would prefer to buy a voluntary carbon offset whilst booking a flight or directly after through the same platform to buying it elsewhere.

(viii) Behavioural economics: choice architecture

Three types of nudges have been tested in the literature: social comparison, defaults and framing. In contrast to some other types of pro-environmental behaviour, such as home energy and water efficiency, carbon offsets represent a tough test for choice architects as they carry a financial cost without immediate or visible personal benefits.

Looking at social norms, Huber et al. (2018) examine the effect of two types of social norm signals and find that institutional signals positively impact purchases (when cost is low), but the group norm signal had, on average, a small negative effect. High costs, however, lead to negative boomerang effects, decreasing willingness to pay. The authors also report on an intention-behaviour gap: whilst a quarter of participants expressed willingness-to-offset, only 11% actually paid to offset their emissions once prompted to do so. Loschel et al. (2013, p. 18) explain the effect of social norms through the utility framework: people suffer a disutility from not following their expectations about others' behaviour; to mitigate this, they would "contribute a positive amount up to the level where their marginal disutility from falling behind equals the marginal utility from income not spend on the public good." However, while they find a positive impact of collective action (i.e. requiring all subjects in a group to allocate the same, median, amount) on payments, they do not find social norms to have a statistically significant effect (ibid.). By contrast, Araghi et al. (2014) do observe an improved utility from offsetting when individuals are informed of the collective participation rate, but they do not examine whether this improved utility translates into behaviour.

Loss aversion may be leveraged by changing the default option or framing the message so as to emphasise losses of an outcome rather than gains. As per the former, Arana and Leon (2012) experimentally test the effect of an opt-out default on the purchase of voluntary carbon offsets among business conference attendees, finding that average payment is 54% higher when participants are given the option to opt-out (€40 vs. €26). Kesternich et al. (2019) circumvent the ethical and policy issues surrounding defaults (Smith et al., 2013) by introducing active choice. In a large-scale field experiment examining carbon offset contributions when purchasing an online ticket for a long-distance bus ride, they find that the requirement of an active choice (i.e. no default, with mandatory opt-in or opt-out selection) boosts participation rates by almost 50%.

A single study examines the effect of loss framing. In a two-part experiment, Zhang and co-authors (2019) first look at the effect of valence framing and the effect of spatial- and temporal distance framing, as based on the construal level theory, on perceived message credibility and how this, in turn, affects stated preferences. Whilst they do identify a significant effect of one source of message credibility (trustworthiness) on purchase intentions (Zhang et al., 2018), they do not find this to be influenced by message framing. The authors thus only measure framing effects indirectly and only do so on preferences, not behaviour.

My own experiment seeks to add to the literature by examining framing effects experimentally – both on stated and revealed preferences.

A different strand of behavioural economic research seeks to identify the cognitive style involved in environmental decision-making by looking at response times. To my knowledge, one such study exists in the domain of voluntary carbon offsetting: in a large extra-laboratory experiment, Lohse et al. (2016) compute response times to be 40% longer for participants who decided to contribute towards climate change mitigation efforts compared to those who decided to collect the money instead.

A final note goes to a short appraisal of the collection of studies. The reader will notice that the studies reviewed show a wide dispersion in the outcome (namely, willingness to offset or pay) as well as in the statistical significance of different variables, making it difficult to draw conclusions and shape (government or corporate) policy accordingly. The variables were discussed in length in chapters 2.4.4 and 2.4.5 (particularly as pertaining to project attributes). As per the former, willingness to offset, where not offsetting at all was an option, ranges from 25% (Huber et al., 2018) to 84% (Van Birgelen et al., 2011), and stands in stark contrast to the actual take-up rate of 1-3% (Aviationbenefits, 2020). Within stated preference studies, too, willingness to pay estimates range from a mean of £1 (€1.20) per flight (Fatihah and Rahim, 2017), to an average of €43 per flight for the whole sample (Akter et al., 2009) and as high as €104 per flight for specific project attributes (Hinnen et al., 2015). Looking at trends across time, willingness to pay seems to vary far more within studies than across them: in one of the earliest online experiments, Brouwer et al. (2008) provide a WTP estimate of €20-33 per flight, six years later Araghi et al. (2014) estimate average WTP to be €22, and in 2020 Rotaris et al. (2020) report their WTP estimates to range between €14 and €66 per flight. All other studies with the exception of Hinnen et al.'s (2015) high-end estimate of €104 fall within this time period and this price range.

This divergence between studies has been attributed to different experimental designs (e.g. offering a "no choice" option or not) and data collection methodologies (Rotaris et al., 2020). It may also stem from qualitatively different samples (nationality, for instance) and different time periods of examination – different events in society and reported in the media may impact voluntary carbon offsetting behaviour subconsciously through availability bias, an "omitted variable" that Jacobsen (2011) incorporates into his model. Finally, even the best researcher is subject to his own biases, from experimental demand effects to anchoring around the price options or middle option provided by the experimenter.

3 METHODOLOGY

3.1 Hypothesis specification

This thesis uses a quantitative experimental approach to test the five hypotheses developed in chapter 2.2.3 and summarised below. The hypotheses, which refer to general pro-environmental behaviour, have for the purpose of the empirical study been made more specific. They now reflect the propositions that underlie and guide the study on the effects of framing on voluntary carbon offsetting. Table 6 presents a summary of the general and study-specific hypotheses.

Table 6: List of study hypotheses

	General hypothesis	**Study-specific hypothesis**
1	Gain-framed environmental messages have a positive impact on an individual's pro-environmental attitudes.	The gain-framed voluntary carbon offsetting message will have a positive impact on air traveller's attitudes towards voluntary carbon offsets
2	Loss-framed environmental messages have a positive impact on an individual's pro-environmental behaviour	The loss-framed voluntary carbon offsetting message will have a positive impact on an air traveller's voluntary carbon offsetting behaviour compared to the gain frame or the no frame message.
3a	Positive attitudes following a gain-framed environmental message will not be reflected in commensurate pro-environmental behaviour	Positive attitudes towards voluntary carbon offsetting will not be reflected in commensurate behaviour (attitude-behaviour gap)
3b	Positive attitudes following a gain-framed environmental message will not be a pre-requisite for pro-environmental behaviour	Positive attitudes towards voluntary carbon offsetting will not be a pre-requisite for offsetting behaviour
4	Positive behavioural intentions following either a gain-framed or loss-framed environmental message will not be reflected in commensurate pro-environmental behaviour	Positive intentions for voluntary carbon offsetting will not be reflected in commensurate behaviour (intention-behaviour gap)

Source: author's own

3.2 The experimental approach

In an experimental design, one or more independent variables are manipulated to determine a potential causal relationship with at least one dependent variable. The experimental approach therefore allows us to evaluate how slightly changing the decision environment affects decisions: here, to test how altering the valence frame of the description of voluntary carbon offsets affects attitudes and purchase behaviour. One type of experiment design – one which I will use in my study – is randomised controlled trial (RCT). RCTs randomly allocate subjects to groups, of which one is a control group that does not receive the intervention and at least

one is a treatment group (Kendall, 2003). This method has a number of strengths: it produces a counterfactual of what would have happened without an intervention, it allows us to measure actual behaviour rather than only stated preferences, and, since allocation to groups is random, it minimises the influence of individual characteristics. For these reasons, there is growing support for their use in research and policy, including specifically for testing nudges and other interventions (Haynes et al., 2012).

Doing an experiment rather than a non-experimental survey was a key decision for my methodology since it allows me to compare different treatments and establish potential causal effects on the participant's decisions. It is also necessary (but not sufficient) for observing and measuring real behaviour. This is especially important due to the contradiction between the high willingness to offset rates found in the literature (between 25% and 84%) and low take-up in reality (1-3%), as discussed in chapter 2.4.

Experiments can be executed in a laboratory, in the field or online (a fourth type of experiment are natural experiments, which are beyond the control of the researcher). Compared to field experiments, laboratory experiments allow for high control of any factors that may influence the outcome other than the intervention, thereby allowing us to test mechanisms behind theory and establish causal relationships, which makes them higher in internal validity (Roe and Just, 2009). Laboratory experiments are also less costly to the researcher and have better replicability. By contrast, field data from natural experiments and field experiments have less internal validity but higher external validity, defined as "the ability to generalise the relationships found in a study to other persons, times and settings" (Roe and Just, 2009, p. 3). Indeed, situations presented in the lab are often hypothetical and/or more abstract, which is why even in the presence of monetary incentives, decisions may not be the same as in the real world.

I will be doing a within-survey online experiment, which can be considered a type of remote laboratory experiment. The method benefits from a number of advantages of both (standard) laboratory experiments and field experiments: it allows me more control and true participant randomisation, it carries a lower cost, and it is easier to replicate. At the same time, like field experiments, it ensures anonymity (thus reducing the risk that social desirability bias influences the subjects' decisions), is more representative of the population, and resembles the real world alternative, making it more ecologically valid. The experiment is placed within a survey in order to obtain information on the participants that may have been relevant for their decision-making, i.e. the control variables (see section 3.5.3). An online experiment is also the most suitable method for studying voluntary carbon offsetting behaviour specifically because the related behaviour (rather than just preferences) can be triggered within the experiment. Indeed, this very possibility represents the methodological motivation for studying voluntary carbon offsetting. By contrast, a number of pro-environmental behaviours, such as recycling, reducing food waste or changing mode of transport, cannot be both prompted and measured within an online experiment; they would either rely on reported information or necessitate field experiments, with the latter bringing its own methodological drawbacks, as listed in the previous paragraph.

The experiment obtained ethical approval from the University of Ljubljana School of Economics and Business ethics committee (approval n. 8-2021).

3.3 Sample

3.3.1 Target sample

The population under examination in this dissertation are individual decision-makers (rather than firms or government) who make consumption (rather than production) decisions, as defined in chapters 1.1 and 2.2. The study that follows focuses on one type of pro-environmental behaviour and thus sees a narrowing down of the target population. Namely, I am interested in tourists, travelling by air for leisure. First, the focus on air travel, rather than other travel or any other carbon emitting activity, is justified by the easier and more reliable match with data on both the polluting activity and the take-up and trends. I have also decided to include in the study only those tourists, who travelled for leisure. This is because business travel may be seen as categorically different: business travellers may feel lower responsibility for their emissions since they stem from a work obligation rather than personal choice (Schwirplies et al., 2019). The purchase of air travel tickets of employees is also often made by others within the organisation and in accordance with rigid firm or institution procedures, making offsetting more difficult.

3.3.2 Sampling procedure

The main experiment, its pilot and the screening survey, were all prepared and published in Qualtrics, an online survey tool, and implemented through Prolific. Prolific is an online platform for recruitment and payment of participants for academic research. Compared to MTurk and CrowdFlower, two alternative online research platforms, Prolific participants have been found to be more diverse, have better response rates and, most importantly, produce higher data quality (Peer et al., 2017). There are over 150,000 participants from all over the world registered on Prolific and the experimenter has the option to filter-in for his or her research any of the over 100 categories of socio-demographic data the volunteers have filled in. To maximise the experiment participant's understanding of the nuances in the description of voluntary carbon offsets – the main component differentiating the treatments – I made my study only available to native English speakers. A second requirement was that the participant is willing to take part in studies involving deception, since the study did not include perfect information upfront (see section 3.5). I did not apply any other inbuilt filters so as to maximise participant heterogeneity. I required two additional conditions for inclusion in the experiment: the participant must have flown for leisure at least once since 2015 and he or she must have booked their own flight in this period. The two requirements rest on the assumption that people may feel less personal responsibility for a polluting activity if it was not their choice to engage in it (Schwirplies et al., 2019), if they were not the ones who paid for it, or if it took place long ago. Within the population of Prolific users, who qualified for the survey according to the above criteria, the sampling for the study was done through a simple random sampling procedure.

3.4 Pre-testing

Before finalising and launching the main experiment, I conducted three pre-tests. Pre-tests are important for surveys because they allow the researcher to improve the understanding of the experiment- and questionnaire components of the survey (e.g. Harrison, 2010). I adopted a mixed-methods pre-testing approach, conducting first a focus group to gain better insight into how the participant perceives the treatment conditions, particularly the frame, how (not just if) it can be improved, and how the participant interprets the questions that follow. I followed with a two-part quantitative pilot study on the target population, which was preceded by a screening survey to filter-in the prospective participants (see 3.3.2). Both the focus group and the study pilots included manipulation checks since the correct interpretation of the frame was essential for result validity.

3.4.1 Focus group

The first pre-test was a focus group with six students of the European Master in Tourism Management. The invitation to the focus group was sent to students with a high degree of fluency in English to ensure better understanding of the frame and engaging participation in the discussion: 33 students enrolled in the International Master in Business and Organisation at the University of Ljubljana, 21 students enrolled in the European Master in Tourism Management (of which University of Ljubljana is one of three participating universities) and a further 9 exchange students from English speaking countries at the School of Economics and Business. Six students accepted the invitation to the focus group, which represents a 9.5% response rate. Though low, the size of the focus group in the end was within the recommended range of 4-8 for the most effective and fruitful discussion (e.g. Wilkinson, 2008).

The focus group took place remotely via a video Zoom call due to Covid-19 restrictions. Since it was a small group of engaging individuals, the effectiveness of the pre-test did not suffer from the medium of communication. Prior to participating, the participants received a consent sheet, informing them of their role, risks (none) and benefits to participating, and use of data. The structure of the focus group followed the survey, with each section and survey question being subject to discussion. The aim was to consult the participants on the treatment manipulations, on the reasons they may have for purchasing a voluntary carbon offset or not (to optimise the multiple choice shortlist), on the constructs for attitudes, as well as on the clarity and understanding of each question and statement, and the very length of the survey.

Two main changes to the experiment followed from the focus group. In terms of the manipulation, the participants considered the loss frame too aggressive in tone, which leads to a feeling of guilt, warning that it may result in a boomerang effect and lead to lower likelihood of purchasing a carbon offset. I therefore softened the tone of the loss frame; the eradication of guilt triggered by the loss frame, however, was not appropriate since one theoretical explanation for loss aversion in the domain of public goods may indeed be affect, namely guilt (e.g. Amatulli et al., 2017). Second, some focus group participants highlighted that it would be easy for them to allocate any additional earnings towards purchasing a carbon

offset since it "is not their money anyway". To mitigate this house money effect, I added a real effort task to give the subjects the (rightful) impression that they earned the money (the task is elaborated on in section 3.5.1). As per the duration of the survey, the focus group participants considered it appropriate.

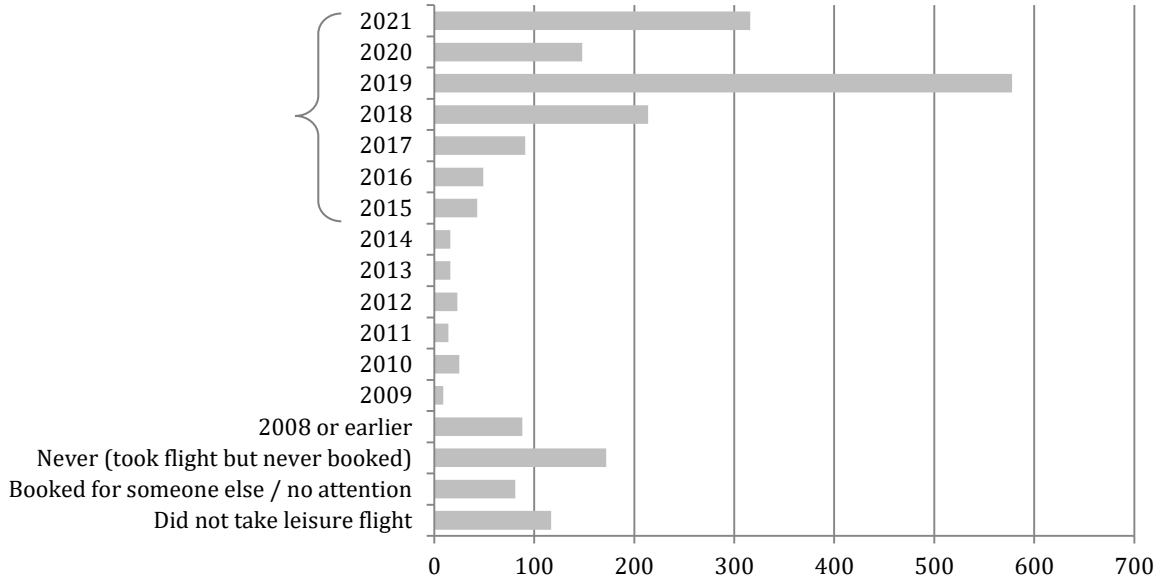
3.4.2 Screening survey

Since the two additional requirements were too specific to be captured in the provided screeners, I conducted a pre-screening survey, as per Prolific guidelines. The 1-minute survey asked the participants to indicate the most recent year, in which they went on holiday, travelled abroad for leisure, travelled abroad for business, took a flight for leisure and took a flight for business (the first three questions were included to ensure the subjects did not guess the aim of the survey, which could have tempted them to falsify their information in order to be invited to the main experiment). Conditional on a positive answer to the final two statements, subjects were asked to indicate the last time (year) they booked the leisure and/or business flight. The main study's target group were the individuals who booked their own leisure flight at least once since 2015. Whilst the survey did not ask after other travel purposes, such as religion or visiting relatives and friends, it is possible that survey participants do not know of this classification and indicated leisure nonetheless.

Finally, the participants were asked to indicate their age, gender and income range; if the distribution along this socio-demographic data had been heavily skewed (more so than the general population or Prolific's participant pool), I could have used this data to better target the main experiment. The survey took 1 minute and paid £0.10, which is above Prolific's minimum hourly rate of £5.00. The text for the screening survey is shown in Appendix 4.

The screening survey was made available to 2000 individuals. 1609 participants indicated that they had taken a flight for leisure since 2015, but 95 of those had never booked a flight themselves and a further 81 booked a flight for someone else or were not paying attention to the survey questions – they indicated a "booked the leisure flight yourself" (latest) year that is later than the "took a leisure flight" year. The final target group for our experiment included 1439 individuals, as shown in Figure 10. This was satisfactory for the pilots and main experiment with a total target sample size of 570; since the monetary incentive to participate was higher in the experiment than in the screener survey, I presumed at least a half of those who get invited to the experiment will take part.

Figure 10: Latest year, in which the participants, who booked at least one leisure flight themselves, took a flight for leisure



Source: author's own

3.4.3 Pilot study

The aim of the quantitative pre-test was to conduct the manipulation check on a larger sample of individuals, to see how long the entire survey takes, to get short feedback, and to do so through the same method as the main experiment and on a larger sample than the focus group. I ran two rounds of pilot studies. Both pilots were conducted through the Prolific platform on 60 participants each, evenly divided into the loss frame treatment group, the gain frame treatment group and the control group. They were rewarded £1.50 for participating, which is 50% more than the payment of the main experiment, representing a high estimated £9.00 hourly rate. This was done strategically so as to encourage the participants to offer feedback to the pilot, of which they were informed.

The first pilot study differed to the survey discussed in the focus group only inasmuch as it included the adjustment to the loss frame and manipulation check. The second pilot study replaced the "gift" of £1.50 with a real effort task, with which the participant can *earn* the additional £1.50, a change intended to reduce house money effects and better represent real world economic decisions. It also included slight improvements to the clarity of the manipulation checks.

The manipulation check asked the participants in the gain and loss treatment groups to indicate, based on the description of voluntary carbon offsets provided above, whether they think the text concluded by emphasising what will be gained/improved from purchasing a voluntary carbon offset, and whether they think it emphasised what will be lost/worsened, both on a 5-point Likert scale from 'strongly disagree' to 'strongly agree'. The control group did not see the manipulation check because the description they read did not contain a frame.

To analyse and compare the manipulation check responses I used the independent sample *t* test. The results, presented in Table 7, show that more participants in the gain treatment expressed that the description of voluntary carbon offsets emphasised gains (rather than losses) to the environment (M_{gain}4.4, M_{loss}2.5, $p<0.01$). Likewise, more participants in the loss treatment indicated that the description emphasised losses (not gains) to the environment (M_{gain}1.65, M_{loss}4.3, $p<0.01$).

Table 7: Group statistics

		N	Mean	Std. Deviation	Std. Error Mean
Gain frame manipulation check	Gain treatment	20	4.40	0.821	0.184
	Loss treatment	20	2.50	1.469	0.328
Loss frame manipulation check	Gain treatment	20	1.65	0.813	0.182
	Loss treatment	20	4.30	1.261	0.282

Source: author's own

Table 8: Independent samples t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf. Lower	95% Conf. Upper
Gain frame manipulation check	Equal variances assumed	13.789	0.001	5.050	38	0.000	1.900	0.376	1.138	2.662
	Equal variances not assumed			5.050	29.810	0.000	1.900	0.376	1.131	2.669
Loss frame manipulation check	Equal variances assumed	1.448	0.236	-7.901	38	0.000	-2.650	0.335	-3.329	-1.971
	Equal variances not assumed			-7.901	32.466	0.000	-2.650	0.335	-3.333	-1.967

Source: author's own

Table 8 confirms that the means are statistically different with the Sig. (2-tailed) p-value equal to 0.000 in both manipulation frames. Levene's test for equality of variances indicated variance homogeneity in the loss frame manipulation check (F = 1.448, Sig. = 0.236), confirming the suitability of using an independent samples *t* test. The test showed variances to be unequal in the gain frame manipulation check (F = 13.789, Sig. = 0.001); however, turning to the "Equal variances not assumed" row of the output table, we see that the p-value is still equal to 0.000, validating that the means are indeed statistically different.

Having confirmed the manipulation, the treatments remained unchanged for the main experiment. Based on results of the pilot study I did, however, make some slight adjustments to the questionnaire part of the survey. I removed the question capturing environmental concern, which asked the respondent how serious they consider seven global environmental issues to be, measured on a 4-point Likert scale from 'not at all serious' to 'very serious'. This was done because the results showed that 98% of responses were either 'serious' or 'very

serious', representing a very skewed distribution with limited insight for my model. This second pilot was otherwise identical to the main experiment.

3.5 Experiment design

The within-survey experiment, presented in Appendix 5, was prepared in Qualtrics and distributed to participants via the academic research platform Prolific. Of the 1319 eligible participants (1439 filtered-in in the screening survey, minus the 120 participants of the pilot studies), 450 were invited to take part. Since only one section – the description of voluntary carbon offsets – differed between the treatment groups, the allocation to treatment group was done through the randomiser tool on the Qualtrics platform, and so all 450 target participants accessed the same survey. Including the 17 respondents who returned their submission (this is not unusual and typically happens either due to technical difficulties or from withdrawing consent), 467 participants accessed the survey. However, since the returned submissions were unevenly distributed across treatments, so were the remaining 450 submissions. I therefore increased the number of places to 465 to ensure even allocation to treatment groups. Finally, one participant's submission was rejected because he or she failed multiple attention checks; space was thus made for one more submission to bring the total back up to 465.

The reward for participating was a fixed £1 (GBP being the Prolific currency), which is in line with Prolific's minimum hourly rate requirements for the 10-minute survey. The variable component of the reward was an additional £1, which the participants could either collect or use to purchase a voluntary carbon offset, although they were only informed of this option after completing the task (see below). A higher variable reward was not feasible due to experiment budget constraints. However, it was considered sufficient since the cost of offsetting a short haul flight, for instance from London to Paris, could indeed be as low as £1, depending on the carbon offset provider and project chosen (e.g. on NativeEnergy, n.d.). Since the reward is on the lower threshold, it also avoids the risk of field-price censoring (Harrison and List, 2004), whereby participants with altruistic intentions may choose to collect their earnings because they know they can use those earnings to offset 'in the field' for cheaper, still keeping some of them for themselves as mark-up.

The survey started with an introductory page, which included a brief and vague description of the study – the reader was informed that the research is concerned about people's awareness, knowledge and opinion of voluntary carbon offsets, and that the study will include an optional task. More was not revealed in order to manage expectations surrounding the monetary reward and at the same time prevent any experimenter demand effects. This first page also included information necessary for participants to make an informed decision on whether they provide ethical consent to participating – risks and benefits, use of data and contact address in case of questions – and gave the participant the option to withdraw from the study.

The main body of the study started with a 3-paragraph description of voluntary carbon offsets, including some project examples and sample costs of offsetting. The description itself is value-neutral, but ends with a loss-framed or gain-framed conclusion. The two experimental

conditions are thus: (1) A loss-framed message following the description of voluntary carbon offsetting, and (2) A gain-framed message following the description of voluntary carbon offsetting. The third group is the control and constituted only the description of voluntary carbon offsetting, i.e. without a framed message. The treatment is the independent variable of the experiment. The frames were repeated on the offsetting decision page, but other than that, the experiments were identical across the conditions. The gain and loss framed message, respectively, are provided below.

Gain frame: *"Therefore, by purchasing a voluntary carbon offset for a flight, we can contribute to reducing the net climate change impacts of air travel, and with this to a cleaner and healthier environment."*

Loss frame: *"Therefore, by taking a flight without purchasing a voluntary carbon offset, we may be contributing to higher net carbon emissions and with this to a more polluted and unhealthy environment."*

In order to ensure the participants read the description and frame, the crucial element of the study, they had to answer two attention checks, including one pertaining to the frame. The control group saw the description without any frame and, in line with this, had to complete only one attention check.

The experiment continued on to a real effort task, which the participant could do "in order to earn up to £1.00 to purchase a voluntary carbon offset". If the subject chose to skip the task, he or she would be taken directly to the questionnaire part of the study: questions on attitudes and beliefs, followed by questions capturing value orientation, environmentally-relevant control variables, flying habits and socio-demographics. The questionnaire was crafted based on expert guidelines (Krosnick and Presser, 2009) and sought to maximise both understanding and efficiency. If, on the other hand, the subject decided to engage in the real effort task, he or she would be taken to the task, described in more detail in section 3.5.1, and prompted to indicate where to allocate the potential additional earnings to. This is the real behaviour component of the survey and is elaborated upon in section 3.5.2. The subject then continued to the questionnaire, as reported on in chapter 3.5.3.

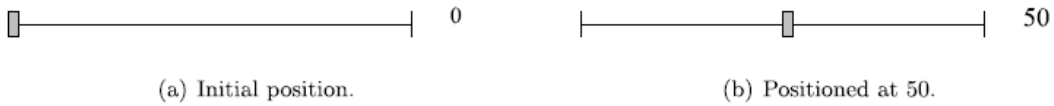
3.5.1 Real effort task

Together with stated effort tasks, real effort tasks represent one of the two ways to study effort in economic experiments. In a real effort experimental design, participants work on a task, with performance in that task determining the outcome, for instance earnings. Their strength vis-à-vis stated effort tasks is that they better match drivers of behaviour in the real world (Charness et al., 2018). One criticism of real effort settings is that there is little opportunity cost of engaging in the task (Dutcher et al., 2015); however, this critique only holds for laboratory experiments, where the subject oftentimes is indeed faced with the only alternative option of waiting in his place. By contrast, in my experiment, the opportunity cost is the time saved by not doing the task (approximately 5 minutes), and on Prolific this could enable earnings from a different experiment or survey.

I incorporated a real effort task into the framing experiment for two reasons: constituting a form of work, the task leads to earnings, which (i) drive decisions that better mimic real world economic decision-making, and (ii) reduce the house money effect, which a simple gift of £1 would suffer from. It is worth noting that an alternative scenario could see the participant allocating his original £1 reward from participating to the purchase of a voluntary carbon offset; in this case, the "real effort" would be doing the survey in the first place, rendering an additional real effort task redundant. However, this option was not possible on the Prolific research platform, which demands a non-transferable minimum hourly rate.

Real effort tasks vary in the level of cognitive ability they demand and in the degree of intrinsic motivation they inspire in the participant, and can be divided into arithmetic, clerical, computer, counting, decoding, puzzle and typing tasks (Carpenter and Huet-Vaughn, 2019). Since the aim here was to capture effort and to not capture cognitive, visual or other skill, which may bias results and necessitate an additional control variable in the model (nor is it needed for the decision at hand), I opted for a slider task. The slider task consists of sets of sliders, which participants have to move to a specified position (Gill and Prowse, 2012), as shown in Figure 11. As the creators of the task argue, the strengths of the slider task are its simplicity and replicability; it also requires no pre-existing knowledge on the one hand, and guess work, on the other (ibid.). An additional advantage is that it can be designed in Qualtrics and thus integrated directly into a longer survey, as demonstrated in Faravelli et al. (2019).

Figure 11: The original slider task

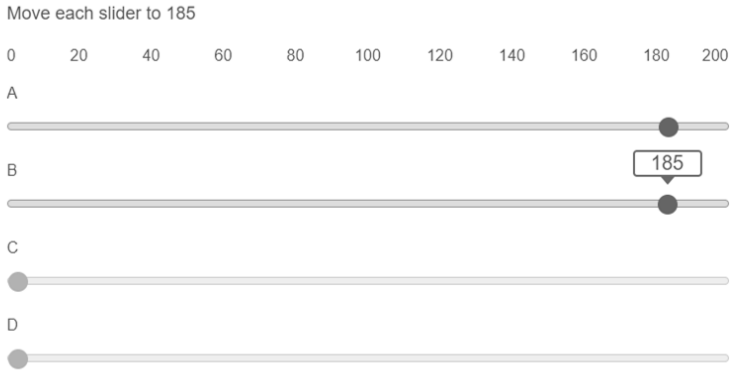


Source: author's own

The framing experiment included 10 sets of four sliders, illustrated in Figure 12. The task required the subject to move each of the four sliders A-D to the specified value. If any of the sliders were not correctly placed, a warning would be displayed and the subject could not proceed to the next slider set. The subject could choose to end the task at any time by selecting the "end the task" button, in which case he or she would be taken to the earnings allocation decision page, followed by the questionnaire.

Each set of correctly placed sliders yielded £0.10. Participants who finished all 10 sets earned £1.00 and participants who completed less earned proportionately to how many sets they completed.

Figure 12: Schematic representation of the slider task used in the experiment



Source: author's own

3.5.2 Measurement instruments

Behaviour. Since I was interested in the effect of framing on pro-environmental behaviour, the main variable of interest in the experiment was actual behaviour. This was a binary yes-no variable that depended on the respondent's decision on whether to collect the earnings from the real effort task – in which case his or her remuneration would increase from £1 to £2 – or allocate them towards the purchase of a voluntary carbon offset. The order, in which the two options were displayed to the participant, was randomised in order to eliminate random response- and order effects. Data analysis showed that order had no statistically significant effect on the decision (see chapter 4.2). Integrating purchase into the experiment directly was not feasible, nor was it appropriate, since it would prolong the survey and represent additional effort which could sway some participants away from this option. Instead, the participant was asked to select a carbon offset provider they would like the experimenter to allocate their earnings to. Four choices (Atmosfair, myclimate, Native Energy and Terrapass) in addition to an "I don't mind" option were given in order to prevent effects of potential pre-existing aversion to a specific provider. All listed providers are third party certified, well-known and ensure even geographic distribution. Since payment was not made directly, I safeguarded credibility by assuring the participants explicitly that their earnings will be allocated to the carbon offset provider they select, that we as scientists have no commercial relation to any provider, and that we can be contacted (email provided) to provide receipts of purchase after the study has been completed. Proofs of payment to the offset providers are provided in Appendix 14.

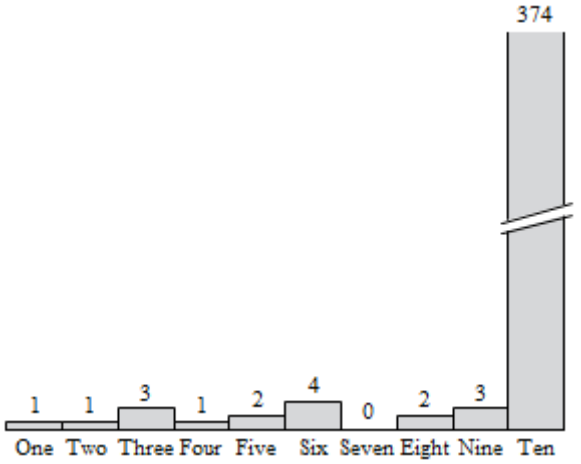
Stated preferences. Behaviour-specific preferences were measured through attitude towards offsetting and intention or willingness to offset. Attitude towards offsetting was computed as the average value of the participant's opinions on voluntary carbon offsets for flights, captured in three 6-point Likert scale items: from very unreasonable to very reasonable, from very ineffective use of money to very effective use of money, and from very unpleasant to very pleasant. The construct is based on Ajzen (1991) and was adapted from Choi and Ritchie (2014): bad-good dichotomy was replaced by unpleasant-pleasant because the former is too vague (a critique also brought up by focus group participants) and worthless-valuable was

made more precise, since "valuable" carries more than one meaning (namely, sentimental and monetary value). A 6-point Likert scale was used to avoid 'satisficing', i.e. respondents choosing the middle option due to fatigue or disinterest (Krosnick, 1991), though this does mean that participants with a genuinely neutral attitude were forced to make a decision (Krosnick and Presser, 2009). To assess the reliability and internal consistency of the measurement scale for attitude, I used the Cronbach's alpha reliability coefficient. The value of Cronbach's α was 0.784, which exceeds the 0.70 threshold established in the literature (Hair et al., 1998); the value also did not increase with the removal of any one item, confirming the scale has high reliability.

The second measure of preferences was willingness or intention to offset. This was also a binary yes-no indicator that reflected the participant's decision on whether or not to engage in the task. When the task was introduced, the participant was only informed and reminded that the task will lead to earnings to purchase a voluntary carbon offset. Care was taken when crafting the text to ensure the possibility to collect these earnings was implicitly excluded. Therefore, a rejection of the task can be considered a negative intention to purchase a voluntary carbon offset, whilst engagement in the task reflects a positive intention to purchase.

The aim was to quantify this intention through the number of sliders completed. However, since the distribution was heavily skewed (see Figure 13), with 96% of participants who expressed intention completing all ten sets of sliders, I opted for a binary intention variable. This variable was used to identify a potential gap between intention and actual offsetting behaviour, but was not incorporated into the model since it is categorised by complete separation (a "no" on intention will by design lead to "no" on behaviour).

Figure 13: Willingness to offset – number of sliders completed



Source: author's own

3.5.3 Control variables

The goal of the experimental design is to isolate the framing effect on behaviour: to delineate the effect of the frame of the description of voluntary carbon offsets on purchasing an offset from any other reasons an individual may have for purchasing or not purchasing it. Whilst the participants were asked after the reasons for their decision, their responses can only benefit a comparison between the participants and facilitate profile characterisation. Explicit justifications were not used to explain behaviour in my model since they can reflect ex-post rationalisation, especially where a socially desirable activity is concerned. I therefore sought to capture as many possible drivers of behaviour within the questionnaire, leading to, together with socio-demographic covariates, a total of 25 control variables. It must be noted at this point that whilst the hypothesis of loss framing influencing behaviour rests on the behavioural economics assumption of the relative importance of choice architecture vis-à-vis individual preference heterogeneity, the latter cannot be excluded as determinants upfront but only through statistical analysis. The control variables are elaborated on below and listed in Table 9.

Beliefs. The survey asked after the following beliefs, which could influence an individual's preferences around carbon offsetting: belief in personal responsibility in climate change, trust in voluntary carbon offset projects (i.e. that they will indeed be carried out), belief in project output efficacy (i.e. that the projects financed through voluntary carbon offsetting have the intended positive effects on the environment), and belief in personal control over whether or not to purchase a carbon offset (self-efficacy). All were measured on a 6-point Likert scale from 'Strongly disagree' to 'Strongly agree'. All statements were the author's own, but were grounded in findings from the literature: the influence of belief in project efficacy (Lu and Shon, 2012) and of belief in own contribution to climate change (Choi and Ritchie, 2014) on voluntary carbon offsetting, and an effect on behaviour more generally of trust in the organisations responsible (e.g. Ouyang et al., 2017) and self-efficacy (Bandura, 1977). Subjective norm effects were captured through the participant's belief about the behaviour of the people close to them and about the beliefs of those close to them about their own behaviour. The two items were taken from Choi and Ritchie (2014) and showed high reliability (Cronbach's $\alpha = 0.901$).

Values. According to the value-belief-norm theory, value orientation influences behaviour through its effects on beliefs (ecological worldview, negative consequences for things of value and perceived ability to reduce threat) and personal norms (Stern, 2000). Stern and colleagues (1998) distinguish three general value orientations: egoistic, where individuals seek to maximise benefits to the self, altruistic, where concern for the welfare of other humans dominates, and biospheric, reflecting a higher regard for the natural world. The items that capture the three value orientations in the experiment were adopted from Steg et al. (2005) and are measured on a 9-point scale developed by Schwartz (1992), which ranges from -1 ('Opposed to my values') to +7 ('Of supreme importance'). After scale reliability analysis, I removed the item 'Wealth' from the egoistic value orientation variable, which improved Chronbach's α from 0.779 to 0.785. I also removed item 'World at peace' from the altruistic

value orientation variable, raising Chronbach's α from 0.850 to 0.855. The reliability analysis of the biospheric value orientation scale showed a very high Cronbach's α of 0.932, which would not be improved with the removal of any one item and thus remained as-is. An alternative approach would be to lean on Schultz's (2001) measure for people's concern for environmental problems. This scale involves respondents having to indicate why they find a particular environmental problem concerning (i.e. due to its impact on one's own lifestyle, other humans or the living environment), with the reasons provided then divided into the three value orientations above. Its strength lies in reducing priming effects, since environmental concern is expressed either way, with the only factor of differentiation the justification, which the participants may not suspect is being qualitatively evaluated. However, it is difficult to draw conclusions on value orientation since the problem elicited by the participant will affect the reasons for why it is concerning: for instance, some environmental problems cause damage to wildlife but not human health; others do not hurt wildlife but impact human lifestyle, and so on.

Environmental lifestyle. A number of environmentally-relevant lifestyle factors may impact preferences and/or behaviour around carbon offsetting and were thus also included in the statistical model. Environmental identity, captured through level of agreement with the statement "I consider myself an eco-friendly person", may be positively correlated with both preferences and behaviour (see, for instance, Sparks and Shepherd, 1992). Membership in an environmental movement and engagement in green behaviours on a daily basis may also be related to stronger preferences around offsetting, since all three are shaped by biospheric values (Stern et al., 1999; van der Werff et al., 2013). The two variables were also included in Xiao and Dunlap's (2007) Model for Environment Concern. As per behaviour, the two variables could affect it either positively through preferences or, indeed, negatively through moral licensing - an individual may justify and allow themselves to do an activity damaging to the environment (here, flying without purchasing a carbon offset) after engaging in an activity that benefits it, such as green activism or cycling to work. A similar effect could arise from past donation to environmental causes. Finally, this set of questions also aims to capture potential financial preferences influencing attitudes and behaviour. For this, I use the environment-economy trade-off scale from Xiao and Dunlap's (2007) Model for environmental concern. This component is important because a low willingness to pay for environmental protection may override preferences around carbon offsets to directly reduce likelihood of actual behaviour. Three statements form the scale: whether the individual would be, in order to improve environmental protection, willing to pay for higher prices to industry and higher taxes to the government, and willing to accept more unemployment. A reliability check showed the first two statements to load together strongly, whilst the removal of the third from the scale increased Cronbach's α from 0.776 to 0.809. Thus, I took the average value of the former two statements for the environment-economy trade-off variable in my model. All items in this section were measured on a 5-point Likert scale from 'Strongly disagree' to 'Strongly agree'.

Table 9: List of variables with measures

Variable	Statement	Measure	Source
Attitudes (ATT)	For me to pay for voluntary offsets of my flights would be: ATT1: ATT2: ATT3:	 Very unreasonable (1) / very reasonable (6) A very ineffective use of money (1) / a very effective use of money (6) Very unpleasant (1) / very pleasant (6)	Choi and Ritchie (2014)
Belief in personal responsibility (BPR)	If I take a flight, my actions contribute to climate change	Strongly disagree (1) / strongly agree (6)	*Authors' own*
Trust in voluntary carbon offset projects (TP)	Voluntary carbon offsets will reduce carbon emissions elsewhere through VCO projects	Strongly disagree (1) / strongly agree (6)	*Authors' own*
Belief in project output efficacy (BPE)	Projects funded through VCOs will positively impact the environment	Strongly disagree (1) / strongly agree (6)	*Authors' own*
Belief in self efficacy (BSE)	It is mostly up to me whether or not I pay for voluntary offsets of my flights.	Strongly disagree (1) / strongly agree (6)	Choi and Ritchie (2014)
Subjective norms (SN)	SN1: Most people who are important to me would think that I should pay for voluntary carbon offsets SN2: Most people who are close to me would themselves pay for voluntary offsets of their flights	Strongly disagree (1) / strongly agree (6)	Choi and Ritchie (2014)
Altruistic value orientation (VAL_ALT)	VA1: Social justice VA2: Helpfulness VA3: Equality (VA4: A world at peace – *removed*)	Opposed to my values (-1) / of supreme importance (7)	Steg et al. (2005)
Biospheric value orientation (VAL_BIO)	VB1: Protecting the environment VB2: Preventing pollution VB3: Respecting the earth VB4: Unity with nature	Opposed to my values (-1) / of supreme importance (7)	Steg et al. (2005)
Egoistic value orientation (VAL_EGO)	VE1: Authority VE2: Social power (VE3: Wealth – *removed*) VE4: Influence	Opposed to my values (-1) / of supreme importance (7)	Steg et al. (2005)
Environmental identity (IDENT)	I consider myself an eco-friendly person	Strongly disagree (1) / strongly agree (5)	*Authors' own*
Green daily behaviour (DAILY)	I engage in green lifestyle behaviours on a daily basis	Strongly disagree (1) / strongly agree (5)	*Authors' own*
Donation to env causes (DONAT)	I donate to environmental causes	Strongly disagree (1) / strongly agree (5)	*Authors' own*
Involvement in environmental movement (MOVEM)	I am involved in the environmental movement	Strongly disagree (1) / strongly agree (5)	*Authors' own*

(Table continues)

Table 9: List of variables with measure (cont.)

Variable	Statement	Measure	Source
Environment-economy trade-off (ENV-ECON)	ENV-ECON1: I would be willing to pay higher taxes to the government to improve environmental protection ENV-ECON2: I would be willing to pay higher prices (ENV-ECON3: I would accept more unemployment if needed to better protect the environment – *removed*)	Strongly disagree (1) / strongly agree (5)	Xiao and Dunlap (2007)
Other control measures			
Frequency of flying (FREQ)	On a typical (pre Covid-19) year, how frequently do you book and take a flight for leisure purposes	Never (1) / More than 5x (5)	*Authors' own*
Covid-19 impact (COVID)	Were any of your flights cancelled due to the measures accompanying Covid-19	Yes / no	*Authors' own*
Familiarity with VCOs (FAM)	Prior to this survey, how familiar were you with voluntary carbon offsets?	Not at all familiar (1) / Very familiar (5)	*Authors' own*
Past purchase of VCOs (PURCH)	Have you ever purchased a voluntary carbon offset?	No / yes for flight / yes for other activity	

Source: author's own

Flying and carbon offsetting experience. Experiment participants were asked after their familiarity with voluntary carbon offsetting (from 1- 'not at all familiar' to 5-'very familiar', with elaborations to avoid ambiguity) and past purchase experience, where the subjects could indicate that they have either never purchased an offset, or that they had offset a flight or a different activity. The survey also asked participants to mark how frequently they take a flight for leisure, with flight frequency potentially influencing environmental guilt and associated likelihood of offsetting. A final question sought to capture any Covid-19 effects, through flight cancellations, on people's offsetting preferences.

Socio-demographic variables. The final section contained a number of socio-demographic questions that may be associated with preferences or behaviour around offsetting: gender, age, income range, political orientation, highest level of education completed, employment status and number of children. For each socio-demographic question, the participant was given the possibility to not disclose information. This option did reduce the number of responses to the socio-demographic questions (leading to empty values for the analysis) but at the same time reduced the withdrawal rate from the experiment entire and risk of false information, since many participants may wish to avoid providing sensitive information, even if the responses are anonymous. Questions from other sections, however, were mandatory.

3.6 Risks and mitigation measures

In order to optimise outcome validity, I sought to identify as many risks of the experiment as possible ex-ante. The risks and their mitigation measures are reported on below.

3.6.1 Common method bias

Common method variance is "variance that is attributable to the measurement method rather than to the constructs the measures represent" (Podsakoff et al., 2003, p. 879). It is problematic because it is one of the main sources of measuring error, influencing the relationship between the two or more constructs that are measured through the same method, i.e. in the same survey or on the same sample. One of the most common sources of common method bias is consistency bias, whereby the participant makes choices so as to ensure consistency even if that goes against his or her preferences otherwise.

In my experiment, common method bias could influence the strength and direction of the correlation between preferences and behaviour. I minimised method bias effects on the relationship between my two main constructs – attitudes and behaviour – through survey order randomisation. Rather than all participants first completing the experimental component (real effort task) and indicating their offsetting decision before proceeding to the survey questions – as described in section 3.5 – half of the participants in each treatment group were, after having read the carbon offsetting text, asked to indicate their attitudes and beliefs around voluntary carbon offsetting before being taken to the task. Since the intention variable is deterministic, in that absence of intention cannot lead to behaviour, it was combined with the behaviour component in the randomisation process. Whilst correlation between intention and behaviour can be attributed to a consistency 'bias', so, too, could the *absence* of a relationship between the two variables be the result of other biases, elaborated on below.

Finally, within-section consistency bias was also reduced through item randomisation, namely in the environmental lifestyle section and on the earnings allocation decision page.

3.6.2 Other biases

A number of biases may affect the indicated preferences around carbon offsetting or the decision to purchase an offset within the experiment. Owing to the sufficiently high sample size and participant randomisation, these biases should not affect the outcome variables differently across the treatment groups. Nevertheless, I introduced additional measures to mitigate each bias, listed and described below.

Moral licensing effect. A moral licensing effect occurs when an individual allows themselves to engage in an activity that is damaging to the environment after behaving in an environmentally-friendly way somewhere else (Merritt et al., 2010). Concretely, the moral licensing effect would lead an individual to be less likely to purchase voluntary carbon offsets if they behave pro-environmentally on a daily basis. This is tested and controlled for with questions pertaining to green daily behaviour.

House-money effect. This bias, first documented by Thaler and Johnson (1990), refers to increased risk-taking in investment decisions subsequent to gains reaped from previous investments. Applied to decision-making within the framing experiment, participants may be more likely to purchase an offset since the money was not yet theirs. Any counterbalancing endowment effect is unlikely to take place because the financial reward is gain-framed – i.e. participants necessarily make an earning through this experiment, never a loss, as per Prolific policy. An invoice mechanism that would have turned the financial decision into a loss-frame would risk disproportionately low likelihood of offsetting due to high cost of effort (higher than in the real world where airlines give the option of offsetting the flight with one click), as Tyers (2016) finds in his experiment, where only 1 of 1626 participants paid for an offset.

I sought to reduce the house-money effect by incorporating a real effort task, which the participant had to work through in order to obtain the additional £1 reward. The multiple choice question asking after the reasons for the subject's decision also included an option that captured a house money effect or the absence thereof.

Priming effect. This phenomenon concerns the subconscious influence of the exposure to a stimulus on subsequent decisions (Weingarten et al., 2016). Because values and green lifestyle decisions are asked after, they are more salient in the minds of the respondents and may impact the choices they make. This effect was mitigated by placing these questions *after* the main constructs in the experiment.

Experimenter demand effect. Similar to social desirability bias, where respondents seek to portray themselves in a positive light in the eyes of the researcher, experimenter demand effects involve participants deducing what the experimenter is looking for and making decisions accordingly (Zizzo, 2010). Both biases are reduced by ensuring respondent anonymity and by measuring real behaviour rather than just stated preferences – with a tangible financial cost of decisions, participants are less likely to make choices just to please the experimenter.

Self-deception bias. This bias is defined as motivated false belief (Bok, 1989), which may involve, for instance, a respondent believing himself to be more moral or more environmentally-friendly than he is. Whilst this bias may affect stated preferences, as well as the green lifestyle-related questions, it would not affect behaviour, which carries greater commitment (if it does impact behaviour, then the respondent is exactly what he considers himself to be).

3.6.3 Risks pertaining to participant selection and engagement

Pre-screen lies. Participants may enter false information in pre-screening in order to gain access to a study where financial incentives are on offer. This level of risk for my experiment is considered low, since Prolific uses the "About you" section common to all surveys, thereby reducing incentive to respond strategically, since eligibility for one study may mean ineligibility for another. In the screening survey, I also ask after vacation activity in general so as to avoid the participant discerning the eligibility criteria for the main experiment.

Random responses. Participants may not be responding genuinely in order to speed up completion of the survey and obtain the financial reward as quickly as possible. To mitigate this risk, the survey includes a number of attention checks, defined as simple ways to identify whether the participant is paying attention to the survey, reading the questions and exerting enough effort (e.g. "Please select that you strongly disagree here" sandwiched between the statements on beliefs). As per Prolific policy and common practice (Prolific, 2022), submissions with two or more failed attention checks can be rejected and the participant not rewarded, something they are also informed of on the information page. Second, the entire survey, including experiment and questionnaire, is relatively short (confirmed by focus group participants) and the duration announced to volunteers upfront. The third measure to reduce non-genuine responses is to give participants the option to not disclose personal information in the socio-demographic question section, in place of responding randomly in order to be able to finish the survey. The latter two measures are also aimed at reducing dropout rates.

3.6.4 Foreseen impact of the Covid-19 pandemic

Some people participating in the experiment may have had a lower than usual carbon footprint due to travel restrictions following Covid-19. This may have led to lower likelihood of purchasing a carbon offset due to moral reasoning (having already done "their part for the environment" by not taking the flight they planned). A control dummy is included in the model to check whether the participant's decisions may have been influenced by this effect.

4 RESULTS

In this chapter I provide a report and analysis of the results of my study. Before answering the main research questions, reflected in hypotheses 1-4 that were defined in chapter 2 and refined in chapter 3, I provide the reader with information on the study sample characteristics and some main descriptive statistics (section 4.1). The questionnaire component of my experiment allowed me to gain a deeper understanding of who chose to offset their flight - what other individual attributes were connected to having a positive attitude towards offsets and to actually offsetting. This is illustrated in section 4.2. The third section tests the study's five hypotheses.

Data were analysed using Stata version 16.0 and SPSS version 26.0 for Windows. For sections 4.1 and 4.2 I used the cross-tabulation command in SPSS unless stated otherwise. SPSS was also used for the independent samples t-test comparing attitude means across treatment groups (section 4.2.1) and for variable preparation (sections 4.3.1 and 4.3.2). Hypothesis testing was done in Stata using the logit and regress commands[12]. The categorical variables are summarised as percentages; the continuous variables are reported as means or categorised into groups and reported in percentage terms.

4.1 Sample characteristics

In total, 465 individuals participated in the experiment. Owing to the medium of distribution – i.e. through the Prolific research platform rather than, for instance, to students at the university or via personal network – there is a good split between different groups for all socio-demographic characteristics. In terms of gender, female participants represented 57% (267) of the total. In contrast to studies conducted on student populations (e.g. Choi, 2014; Tyers, 2016), this experiment attracted more people from the 35-44 age cohort (30%) and the 25-34 age cohort (29%), followed by the 45-54 group (18%), 55-64 (12%) and 15-24 age group (9%)[13]. In the income category, a little less than a third earned between £1,000 and £2,000 per month, and an additional 27% earned between £2,000 and £3,000. Gross monthly earnings of 8% of participants were higher than £5,000. Just over a half (52%) of respondents had an undergraduate or professional degree, whilst 29% completed high school or less, and 19% held a master's or doctoral degree. The majority of the sample was employed – either full time (60%), part time (13%) or self-employed (10%). Only 5% of the participants were unemployed and 11% were either retired, disabled or students. 41% of individuals in the sample identify themselves as left on the political spectrum, with 36% having political views on the centre and 16% on the right. Finally, almost a half (46%) had no children, 20% had one child, 24% had two children and 9% had three children or more. The sample composition can be seen in Table 10 on the text page.

[12] A number of other commands were employed in Stata – for logistic regression statistics, for linear regression model diagnostics, for margin effects, for stepwise regression, for interaction plots etc.

[13] One reason for the fairly low representation of the youngest group is that underage individuals are not allowed to register on Prolific. The group thus captures 7 years (18-24) rather than the usual 10.

To verify that the randomisation process was successful in allocating individuals from different socio-demographic groups to the three treatments, I conducted the chi-square test of independence on the cross-tabulation between treatment and (separately) gender, age, income, education, employment, political orientation and number of children. Since the p-values of the Pearson test statistic are all above 0.05 (right column in Table 10), I do not reject the null hypothesis that socio-demographic variables are not associated with the treatment groups. In other words, there is a sufficiently even spread of participants across treatment groups.

I was also interested in how familiar with voluntary carbon offsets the participants are and whether they have purchased one in the past. Data show that 413 (89%) individuals have never purchased a carbon offset, which is fairly evenly split between the treatment groups (χ^2 significance level 0.394). The mean familiarity level between 1 ('Not at all familiar') and 5 ('Very familiar') was 2.1, and the median value was 2, which was true for all treatment groups.

Table 10: Sample characteristics

		Control	**Gain frame**	**Loss frame**	**Total**	**χ^2 sig.**
Gender	Female	86	89	92	**267**	0.829
		(55.5%)	(57.4%)	(59.4%)	**(57.4%)**	
	Male	68	66	62	**196**	
		(43.9%)	(42.6%)	(40.0%)	**(42.4%)**	
Age	15-24	12	13	15	**40**	0.494
		(7.7%)	(8.4%)	(9.7%)	**(8.6%)**	
	25-34	46	40	48	**134**	
		(29.7%)	(25.8%)	(31.0%)	**(28.8%)**	
	35-44	53	45	42	**140**	
		(34.2%)	(29.0%)	(27.1%)	**(30.1%)**	
	45-54	30	28	26	**84**	
		(19.4%)	(18.1%)	(16.8%)	**(18.1%)**	
	55-64	13	21	20	**54**	
		(8.4%)	(13.5%)	(12.9%)	**(11.6%)**	
	65 or above	1	7	4	**12**	
		(0.6%)	(4.5%)	(2.6%)	**(2.6%)**	
Income	£0 – £999	16	15	24	**55**	0.844
		(10.9%)	(10.0%)	(16.6%)	**(12.4%)**	
	£1,000 - £1,999	52	48	44	**144**	
		(35.4%)	(32%)	(30.3%)	**(32.6%)**	
	£2,000 - £2,999	39	42	39	**120**	
		(26.5%)	(28.0%)	(26.9%)	**(27.1%)**	
	£3,000 - £4,999	28	29	29	**86**	
		(19.0%)	(19.3%)	(20.0%)	**(19.5%)**	
	£5,000 - £7,999	8	10	5	**23**	
		(5.4%)	(6.7%)	(3.4%)	**(5.2%)**	
	£8,000 or above	4	6	4	**14**	
		(2.7%)	(4.0%)	(2.8%)	**(3.2%)**	

(Table continues)

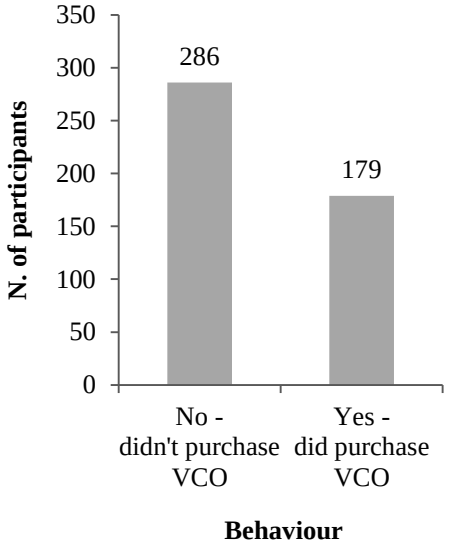
Table 10: Sample characteristics (cont.)

		Control	Gain frame	Loss frame	Total	χ^2 sig.
Education	High school or less	45 (29.0%)	43 (27.7%)	48 (31.0%)	**136 (29.2%)**	0.232
	Undergraduate or professional degree	73 (47.1%)	82 (52.9%)	87 (56.1%)	**242 (52.0%)**	
	Master's degree or above	36 (23.2%)	30 (19.4%)	20 (12.9%)	**86 (18.5%)**	
Employment	Employed full time	99 (63.9%)	90 (58.1%)	91 (58.7%)	**280 (60.2%)**	0.967
	Employed part time	15 (9.7%)	21 (13.5%)	22 (14.2%)	**58 (12.5%)**	
	Self-employed	16 (10.3%)	15 (9.7%)	15 (9.9%)	**46 (9.9%)**	
	Unemployed	8 (5.2%)	9 (5.8%)	8 (5.4%)	**25 (5.4%)**	
	Other	13 (8.4%)	20 (12.9%)	17 (10.8%)	**50 (10.8%)**	
Political orientation	Left	61 (39.4%)	71 (45.8%)	59 (38.1%)	**191 (41.1%)**	0.782
	Centre	55 (35.5%)	55 (35.5%)	59 (38.1%)	**169 (36.3%)**	
	Right	28 (18.1%)	20 (12.9%)	27 (17.4%)	**75 (16.1%)**	
Number of children	None	81 (52.6%)	72 (47.1%)	60 (39.2%)	**213 (46.3%)**	0.244
	One	22 (14.3%)	30 (19.6%)	40 (26.1%)	**92 (20.0%)**	
	Two	40 (26.0%)	35 (22.9%)	37 (24.2%)	**112 (24.3%)**	
	Three	7 (4.5%)	12 (7.8%)	11 (7.2%)	**30 (6.5%)**	
	Four or more	4 (2.6%)	4 (2.6%)	5 (3.3%)	**13 (2.8%)**	
Nationality	United Kingdom	139 (89.7%)	133 (85.8%)	137 (88.4%)	**409 (88.0%)**	0.659
	Ireland	3 (1.9%)	7 (4.5%)	4 (2.6%)	**14 (3.0%)**	
	Australia	2 (1.3%)	4 (2.6%)	3 (1.9%)	**9 (1.9%)**	
	Other	11 (7.1%)	11 (7.1%)	11 (7.1%)	**33 (7.1%)**	
Past purchase	Yes	20 (12.9%)	13 (8.4%)	19 (12.3%)	**52 (11.2%)**	0.394
	No	135 (87.1%)	142 (91.6%)	136 (87.7%)	**413 (88.8%)**	

Notes. Where the items do not add up to 100% within each category, the participant chose to not disclose the information. Source: author's own

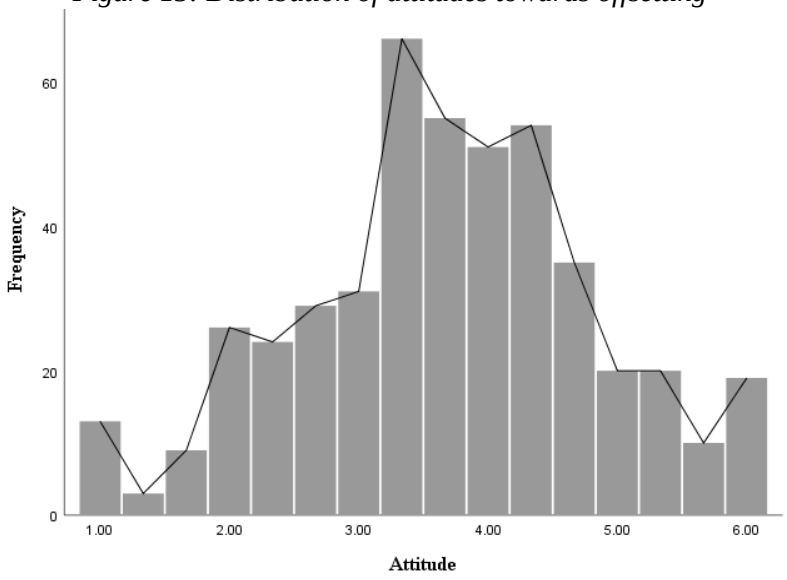
Descriptive statistics. In total, 179 participants (39%) allocated their task earnings towards voluntary carbon offsetting (Figure 14). Of the remaining 286 participants, 74 (26%) chose not to do the real effort task and 212 (74%) carried out the task but decided to collect their earnings instead. Almost all of the subjects who engaged in the task completed all ten rounds (see chapter 3); as such, rather than effort exerted reflecting willingness to contribute, the intention variable became de-facto binary. The distribution of attitudes towards voluntary carbon offsetting is shown in Figure 15. The mean expressed attitude was 3.68 with a standard deviation of 1.15.

Figure 14: Share of participants that purchased a voluntary carbon offset



Source: author's own

Figure 15: Distribution of attitudes towards offsetting

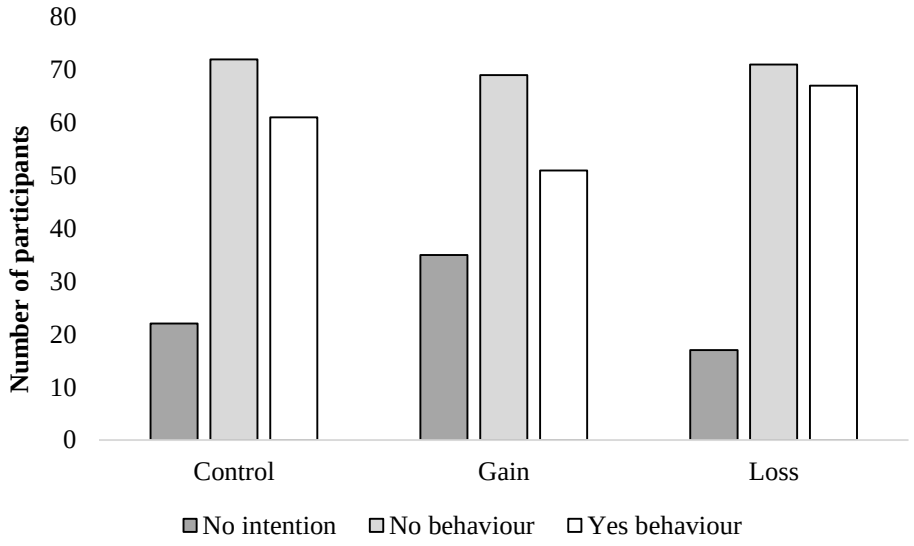


Source: author's own

Breaking these statistics down into treatment groups, it can be shown that more people in the loss frame condition purchased an offset than in the control group (Figure 16). The number of

participants who expressed an intention to offset but did not carry through is stable across the treatment groups. The main difference is in how many participants did not express intention in the first place: 11% in the loss condition, 14% in the control, and 23% in the gain condition. A chi-square test of statistical independence showed the outcomes to not be statistically different but related to the experimental condition at the 5% significant level.

Figure 16: Share of participants that purchased a voluntary carbon offset, per experimental condition



Source: author's own

4.2 Offsetter profiles

It is important to emphasise that although the focus of this thesis is on a specific external driver of behaviour, i.e. the framing nudge, I do not argue that individuals do not differ with respect to their internal drivers of behaviour. Indeed, the behavioural economic discipline does not presume preferences or personality traits are homogeneous; the premise is that *despite* individual heterogeneity, individuals can be equally nudged towards certain behaviour.

The above said, it is valuable to understand whether and which socio-demographic traits, (flying and environmental) habits, and other characteristics are associated with the offsetting decision. This chapter characterises the individuals who decided to purchase a voluntary carbon offset within the experiment, here termed "offsetters". I examine whether they are categorically different to the participants who decided to either not do the real effort task or to collect their earnings from the task (the "non-offsetters"). The first section compares mean attitudes towards voluntary carbon offsetting between socio-demographic groups and across the other major factors that could influence participants' decisions, as drawn from the literature (see chapters 2.4 and 3.5.3). I continue with the differences in behaviour, providing a comparison between offsetters and non-offsetters across these same variables. I conducted pairwise comparison of means for attitudes and a cross-tabulation analysis for behaviour. This methodology follows Mair (2011) and Choi and Ritchie (2014), enabling an interesting

comparison across time and, in particular, between different outcome variables of (their) reported behaviour and the real behaviour in this study.

4.2.1 Positive attitude towards voluntary carbon offsetting

The first research question in the context of offsetter profiles asks whether individuals have different attitudes towards voluntary carbon offsetting depending on which socio-demographic or psychographic group they belong to.

To determine whether there exist statistically significant differences between different groups of individuals I conducted pairwise comparison of attitude means. Since pairwise comparison involves comparing only two groups (pairs) at once, my 30 categories across seven socio-demographic characteristics would require 57 rounds of t-tests. Using SPSS, I therefore first conducted a comparison of means, in which the software automatically runs multiple two-sided tests and indicates any significant pairs. Since conducting multiple pairwise comparisons greatly increases Type I error, i.e. rejecting the null hypothesis when it is true, I applied the Bonferroni adjustment (Salkind, 2010). The Bonferroni adjustment gives a corrected p-value, computed as the product between the uncorrected p-value and k(k-1)/2, where k is the number of columns.

The means comparison showed female participants had higher mean attitudes towards voluntary carbon offsetting than male participants (3.83 and 3.47 out of 6, respectively), as did those employed part time (mean attitude 4.1) when compared to the full-time employed (mean attitude of 3.64). No other groups were found to be statistically different to any other within their socio-demographic category (see table in Appendix 6). Comparing psychographic characteristics, such as values, beliefs and habits shows larger differences: participants who were in the top quartile in terms of both biospheric and altruistic value orientation had higher mean attitudes towards voluntary carbon offsetting (4.18 vs. 3.51 and 3.95 vs. 3.59, respectively). Subjects indicating that they are involved in the environmental movement, have donated to environmental causes in the past, or already offset their travel also had, on aggregate, better attitudes towards carbon offsetting than their counterparts (differences in means of +0.34, +0.36 and +0.61, respectively). Finally, survey respondents who expressed scepticism towards carbon offsetting – reflecting disagreement with the items capturing Trust in voluntary carbon offsetting, Belief in personal responsibility and Belief in output efficacy (mean value below 3 of 6) – had a mean attitude towards voluntary carbon offsetting of only 1.92 out of 6, compared to that of 3.74 of their counterparts. Frequency of flying and egoistic value orientation were not found to be associated with differences in attitudes.

An independent samples *t* test was done on the pairs that the pairwise comparison of attitude means showed to be statistically different. The analysis confirmed the differences to be statistically significant at the 5% level, as shown in Table 11. For all variables, the Levene's test for equality of variances indicated variance homogeneity (significance level above 0.05), thereby confirming the suitability of using the independent samples *t* test for pairwise comparison.

Table 11: Independent samples t test for pairs of socio-demographic and psychographic characteristics

	Levene's Test for Equality of Variances [1]		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% conf. int. Lower	95% conf. int. Upper
Socio-demographic characteristics:									
Employment (part time vs full time)	0.004	0.953	-2.914	336	0.004	-0.468	0.161	-0.783	-0.152
Sex (male vs female)	1.374	0.242	3.385	461	0.001	0.361	0.107	0.152	0.571
Psychographic characteristics and habits:									
Environmental activists'	2.454	0.118	-2.704	463	0.007	-0.338	0.125	-0.583	-0.092
Benevolents'	1.475	0.225	-3.426	463	0.001	-0.365	0.106	-0.574	-0.156
Value orientation: altruistic	1.020	0.313	-3.034	463	0.003	-0.368	0.121	-0.607	-0.130
Value orientation: biospheric	1.377	0.241	-5.611	463	0.000	-0.669	0.119	-0.904	-0.435
Past purchase [illegible]	3.394	0.066	-3.648	463	0.000	-0.607	0.166	-0.934	-0.280
Sceptics'	0.065	0.800	6.537	463	0.000	1.825	0.279	1.276	2.374

Note: [1] Since the Levene's test indicated variance homogeneity, only "equal variances assumed" results of the analysis are shown.

Source: author's own

4.2.2 Characteristics of offsetters

I define offsetter profiles based on relationships between socio-demographic, psychographic, and belief- and habit related variables on the one hand, and offsetting behaviour on the other.

The associations were examined using the cross-tabulation command in SPSS. A cross-tabulation analysis was first done for socio-demographic characteristics: gender, age, income, education, employment, number of children and political orientation. The other factors that may influence offsetting decisions were continuous variables, which were recoded into dummy variables in order to allow for cross-tabulation and draw more effective comparison. Statements on behaviour-specific attitudes, beliefs and subjective norms were measured on a 6-point Likert scale, enabling division into two distinct categories, one reflecting disagreement ('Strongly disagree', 'Disagree' and 'Somewhat disagree') and the other agreement ('Strongly agree', 'Agree' and 'Somewhat agree'). Where the variables are composites of more than one statement, a mean value was taken, such that a mean of 3.5 or above out of 6 represents average agreement and below 3.5 reflects disagreement.

Elsewhere, the 'strongest' individuals in each category were examined separately: those in the top quartile of biospheric, altruistic and egoistic value orientation; and those who expressed agreement with statements that capture past or recurring green behaviour (eco-friendly identity, membership of green movement, donation to environmental causes, and green lifestyle behaviours). Finally, participants were also grouped according to frequency of flying

– where individuals taking more than 3 flights annually were for the purpose of this assessment considered 'frequent fliers' – and whether or not their travel plans were disrupted by measures associated with the Covid-19 pandemic.

The analysis was done for all three decisions the participants could have made: offsetting carbon, collecting earnings from the real effort task and choosing not to do the task. Through this we can see a potential relationship between the covariates and both intention and behaviour, as well as any gaps between intention and behaviour, and how the size of the discrepancy may differ across the groups.

A chi-square test of statistical independence between offsetters and non-offsetters was done for each cross-tabulation in order to determine whether these two groups are statistically different. Here, the non-offsetters are the participants who did not do the task and those who did not offset.

The only socio-demographic variable that was different between offsetters and non-offsetters at the 5% significance level is political orientation (see Table 12). Among those who identify on the left of the political spectrum 46% chose to allocate their task earnings to a voluntary carbon offset provider; only 36% of those on the political centre and 31% from the political right made this decision.

Turning to the relationship between intention and behaviour, one can calculate the gap as the share of participants who chose to collect their additional earnings among those that expressed intention to do so by engaging in task. The results (Table 12, last column) show the largest intention-behaviour gap to be exhibited by individuals in the 25-34 age group (80% expressed intention but not behaviour), those with an income higher than £8,000 per year (89%), individuals with a master's degree (83%), and those who consider themselves on the political centre (77%).

The results, presented in Table 13 show that offsetters and non-offsetters are statistically different when it comes to their personal values, beliefs and attitudes. Namely, 47% of those with a positive attitude towards voluntary carbon offsetting chose to offset within the study, but only 28% of those with a negative attitude did (equivalently, 69% of offsetters expressed a positive attitude towards offsetting). However, these figures also show that there is a non-negligible gap between attitudes and behaviour: over half of the participants with a positive attitude towards offsetting decided to not offset their carbon within the experiment. Interestingly, 56 participants (28%) did offset, even though they expressed a negative attitude towards voluntary carbon offsetting. The variables, on which offsetters and non-offsetters statistically significantly differed, are illustrated in Figure 17 (see chapter 5 for a discussion of this gap).

Table 12: Cross-tabulation results between offsetting behaviour and socio-demographic characteristics

		Non-offsetters (n=286)			Offsetters		
		No intention	No behaviour	Total		χ^2	Intention-behaviour gap
Variable	**Total**	**(n=74)**	**(n=212)**	**(n=286)**	**(n=179)**		
		16%	**46%**	**61%**	**39%**		
Gender	Male	17,9%	46,9%	64,8%	35,2%	1.62	72.38%
	Female	14.6%	44.6%	59.2%	40.8%		75.34%
Age	15-24	25,0%	50,0%	75,0%	25,0%	7.28	66.67%
	25-34	12,7%	49,3%	61,9%	38,1%		79.64%
	35-44	14,3%	47,9%	62,1%	37,9%		77.13%
	45-54	19,0%	34,5%	53,6%	46,4%		64.37%
	55-64	14,8%	42,6%	57,4%	42,6%		74.22%
	65 or above	16,7%	58,3%	75,0%	25,0%		77.73%
Income	£0 – £999	12,7%	47,3%	60,0%	40,0%	2.31	78.83%
	£1,000 - £1,999	21,5%	40,3%	61,8%	38,2%		65.21%
	£2,000 - £2,999	13,3%	50,8%	64,2%	35,8%		79.13%
	£3,000 - £4,999	15,1%	45,3%	60,5%	39,5%		74.88%
	£5,000 - £7,999	8,7%	39,1%	47,8%	52,2%		81.80%
	£8,000 or above	7,1%	57,1%	64,3%	35,7%		88.80%
Education	High school or less	22,1%	41,9%	64,0%	36,0%	2.76	65.47%
	Undergraduate or professional degree	14,9%	47,5%	62,4%	37,6%		76.12%
	Master's degree or above	9,3%	45,3%	54,7%	45,3%		82.82%
Employment	Employed full time	15,4%	47,5%	62,9%	37,1%	7.10	75.52%
	Employed part time	12,1%	36,2%	48,3%	51,7%		74.95%
	Self-employed	21,7%	34,8%	56,5%	43,5%		61.59%
	Unemployed	20,0%	52,0%	72,0%	28,0%		72.22%
	Other	16,1%	51,8%	67,9%	32,1%		76.29%
Number of children	None	17,8%	46,5%	64,3%	35,7%	3.26	72.32%
	One	14,1%	43,5%	57,6%	42,4%		75.52%
	Two	12,5%	43,8%	56,3%	43,8%		77.80%
	Three	20,0%	46,7%	66,7%	33,3%		70.01%
	Four or more	15,4%	53,8%	69,2%	30,8%		77.75%
Political orientation	Left	16,8%	37,7%	54,5%	45,5%	8.14*	69.17%
	Centre	14,8%	49,1%	63,9%	36,1%		76.84%
	Right	21,3%	48,0%	69,3%	30,7%		69.26%

** significant at p<0.05, ** significant at p<0.01.*

Note. Pearson chi-square value and significant level for test of independence between offsetters and non-offsetters (total).

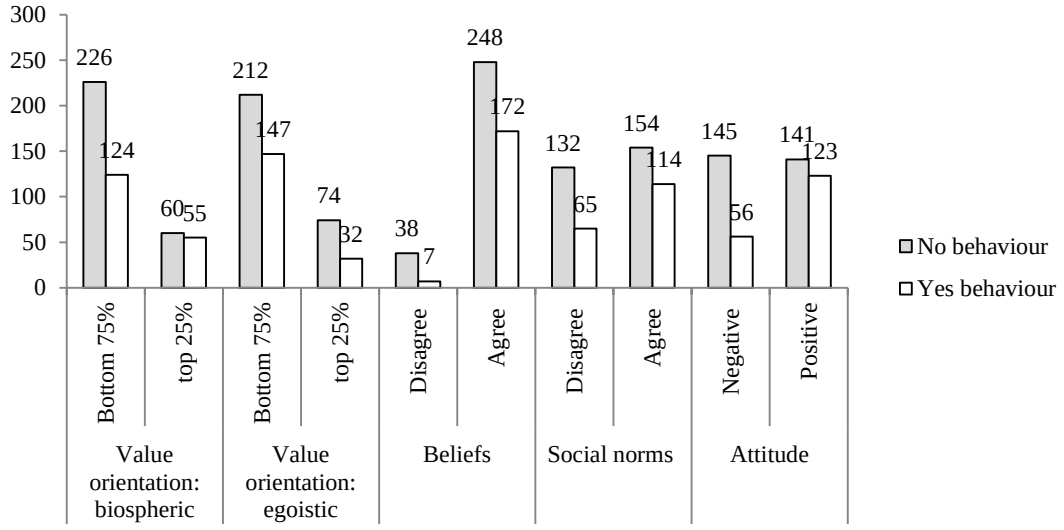
Source: author's own

In terms of beliefs, agreement with items reflecting subjective norms ("Most people who are important to me would think that I should pay for VCOs" and "Most people who are close to me would themselves pay for VCOs for their flights") was statistically significantly associated with offsetting. This relationship was also predicted within the theory of planned

behaviour, though, here again, there remains a gap between the share of participants who agreed with the presence of behaviour-specific subjective norms and those who engaged in the behaviour. Trust in voluntary carbon offset organisations, belief in the effectiveness of their projects and sense of personal responsibility for climate change also differed between offsetters and non-offsetters. This is in line with Choi and Ritchie's (2014) results. A total of 45 participants expressed low levels of behaviour-specific beliefs (mean value below 3.5 of 6); among those, only 7 (15.6%) chose to offset, though due to the low group size, there was only a weak difference between the participants relatively higher on beliefs and the whole sample average (41% vs. 39%).

Egoistic and biospheric value orientations differed between offsetters and non-offsetters at the 5% significance level, though altruistic value orientation was not significantly different. More precisely, fewer participants relatively high on egoistic value orientation and more participants high on biospheric value orientation chose to offset their activity within the study. Offsetters and non-offsetters differed significantly on their position on the environment-economy trade-off: twice as many (25 p.p. more) experiment participants with preference of the environment over the economy – i.e. those who expressed willingness to pay higher taxes to the government and higher prices to industry for environmental protection – than vice versa chose to offset their carbon.

Figure 17: Differences between offsetters and non-offsetters



Source: author's own

Frequency of flying and impact of flight restrictions due to the Covid-19 pandemic did not differ significantly between offsetters and non-offsetters, neither did involvement in an environmental movement and past or recurring donation to environmental causes.

Table 13: Cross-tabulation results between offsetting behaviour and other individual characteristics

		Non-offsetters (n=286)			Offsetters	
		No intention	No behaviour	Total		χ^2
		(n=74)	(n=212)	(n=286)	(n=179)	
Variable	**Total**	**16%**	**46%**	**61%**	**39%**	
Attitude towards voluntary carbon offsetting	Positive	13.3%	40.2%	53.4%	46.6%	16.91**
	Negative	19,4%	52,7%	72,1%	27,9%	
Beliefs: subjective norms	Agree	14,2%	43,3%	57,5%	42,5%	4.37*
	Disagree	18,3%	48,7%	67,0%	33,0%	
Beliefs: trust in VCOs, personal responsibility and output efficacy	Agree	15.2%	43.8%	59,0%	41,0%	11.07**
	Disagree	22.2%	62.2%	84.4%	15.6%	
Value orientation: biospheric	Top 25%	10,4%	41,7%	52,2%	47,8%	5.62 *
	Bottom 75%	17,7%	46,9%	64,6%	35,4%	
Value orientation: altruistic	Top 25%	15.7%	42.6%	58.3%	41.7%	0.60
	Bottom 75%	16.0%	46.5%	62.5%	37.5%	
Value orientation: egoistic	Top 25%	15.0%	55.0%	70.0%	30.0%	3.88*
	Bottom 75%	16.2%	43.0%	59.2%	40.8%	
Past donation to environmental causes	Yes	13,3%	51,8%	65,1%	34,9%	1.86
	No	17,8%	41,1%	58,9%	41,1%	
Involvement in environmental movement	Yes	11,1%	50,0%	61,1%	38,9%	0.01
	No	17,4%	44,3%	61,6%	38,4%	
Environment-economy trade-off	Leaning environment	11.9%	38.5%	50.4%	49.6%	26.94**
	Ambivalent	19.3%	52.9%	72.3%	27.7%	
	Leaning economy	21.6%	53.9%	75.5%	24.5%	
Frequent fliers	Yes - more than 3 flights / year	18,4%	36,7%	55,1%	44,9%	0.95
	No - 2 or fewer flights / year	15,6%	46,6%	62,3%	37,7%	
Covid-19 impact	Yes	13,9%	49,7%	63,6%	36,4%	0.49
	No	17,0%	43,3%	60,3%	39,7%	

** significant at p<0.05, ** significant at p<0.01*

Note. Pearson chi-square value and significant level for test of independence between offsetters and non-offsetters (total).

Source: author's own

Finally, it needed to be confirmed that the order in which the decision options (collect earnings or purchase carbon offset) did not affect the participant's decision. A cross-tabulation between choice order and behaviour is provided in Table 14. The p-value of the Pearson chi-square statistic is 0.615, indicating independence between the order the choices were displayed and the decision taken.

Table 14: Cross-tabulation results between offsetting behaviour and behaviour choice order

		Non-offsetters (n=286)			Offsetters	χ^2
		No intention	**No behaviour**	**Total**		
		(n=74)	(n=212)	(n=286)	(n=179)	
Variable	Total	16%	46%	61%	39%	
Choice order	Collect first	/	55.4%	55.4%	44.6%	0.253
	Purchase first	/	52.9%	52.9%	47.1%	

Source: author's own

4.3 Hypothesis testing

This section reports the main results of the study: the effect of framing on behaviour (hypothesis 2) and on attitude (hypothesis 1), as well as identified gaps between attitude and behaviour (hypotheses 3a and 3b) and intention and behaviour (hypothesis 4). Before analysing the model, data needed to be prepared and the relatively high number of variables reduced, which is reported on in sections 4.3.1 and 4.3.2, respectively. I follow with a description and analysis of the linear regression model for attitude. Section 4.3.4 covers the logistic regression model for behaviour, where I present the main hypothesis results as well as the effects of control variables and response times as an interesting cognitive aspect of behaviour. Section 4.3.5 provides a diagnostic of the gap with attitude, and section 4.3.6 does the same for intentions.

4.3.1 Data preparation

Since all questions in the main body of the questionnaire were mandatory, there was no missing data associated with these variables. Socio-demographic questions, on the other hand, were voluntary since they include sensitive personal information; making these, too, obligatory may have increased false or random responses and even withdrawal from the experiment. Categorical socio-demographic questions, including employment status, education level and political orientation, had a N/A (no answer) option. This was included in the analysis as a separate category to avoid sampling bias. For continuous variables, a total of 29 values were missing, of this 23 for income, 1 for age and 5 for the number of children. For the former, I was able to confirm statistical independence with other socio-demographic characteristics using the cross-tabulation command with chi-square test statistics. The number of empty cells for age and number of children was small enough for statistical randomness. The three variables were thus imputed with the mean of the observed values for each variable: 2,500 for income, 38 for age and 1 for number of children.

The data were then checked for any outliers by looking at the box plot for each variable. No statistical outliers that would not occur due to natural variations in the population were detected.

4.3.2 Variable reduction

With a view to reduce the dimensionality of data and optimise the final set of variables in the model, I conducted principal component analysis. Principal component analysis is a variable-reduction technique that computes so-called principal components – linear combinations of the original variables – maximising variance and at the same time retaining maximum possible variability originally present in the dataset (Jollifee and Cadima, 2016).

Among the 25 control variables in the model, two groups of candidates for dimension reduction were identified. The first group are environmentally-relevant habits and preferences: green identity, daily pro-environmental behaviour, position on the environment-economy trade-off, donation to environmental causes and involvement in an environmental movement. Bartlett's test of sphericity (p-value<0.5) and the Kaiser-Meyer-Olkin measure of sampling adequacy (0.776) both confirm suitability of the use of principal component analysis. The analysis was based on the correlation matrix and extraction was based on eigenvalues greater than 0.5. To prevent numerous variables loading moderately on more than one component, a Varimax rotation procedure with Kaiser normalisation was conducted.

The results show that two factors – green daily behaviour and green identity – loaded onto the same component (Table 15). The remaining three factors – past donation to environmental causes, involvement in a green movement, and position on the environment-economy trade-off – were shown to be independent, and were thus treated as independent variables in my analysis. The four final components cumulatively explain 93.4% of the variance (Table 16). Table 16 also shows that had an eigenvalue threshold of 1.0 been selected, only one component would have been extracted. However, the correlation matrix (Table 17) shows correlations among the five variables to be relatively weak, with values of below 0.5 between all variables except green behaviour and green identity.

Following from this analysis, the factors green behaviour and green identity were merged into a single variable for the final model. This reduced the dimensionality of the data slightly, while at the same time safeguarding the meaning of the combined variable.

Table 15: Green lifestyle - rotated component matrix

Factor \ Component	1	2	3	4
Green behaviour	0.877			
Green identity	0.860			
Donate to environmental causes		0.944		
Involvement in green movement			0.943	
Environment-economy tradeoff				0.942

Source: author's own

Table 16: Green lifestyle – variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Compo-nent	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.720	54.395	54.395	2.720	54.395	54.395	1.663	33.256	33.256
2	0.801	16.026	70.421	0.801	16.026	70.421	1.005	20.100	53.356
3	0.638	12.765	83.186	0.638	12.765	83.186	1.002	20.045	73.401
4	0.513	10.252	93.438	0.513	10.252	93.438	1.002	20.037	93.438
5	0.328	6.562	100.000						

Source: author's own

Table 17: Green lifestyle – correlation matrix

	Green identity	Involvement in green movement	Green behaviour	Donate to env causes	Environment-economy trade-off
Green identity	1.000	0.400	0.671	0.359	0.458
Involvement in green movement	0.400	1.000	0.399	0.462	0.334
Green behaviour	0.671	0.399	1.000	0.368	0.434
Donate to environmental causes	0.359	0.462	0.368	1.000	0.390
Environment-economy trade-off	0.458	0.334	0.434	0.390	1.000

Source: author's own

The second group of candidates for dimension reduction reflect the beliefs that may impact voluntary carbon offsetting – beliefs about personal responsibility in climate change in general, and in offsetting a flight in particular (self-efficacy), about the trustworthiness of offsetting organisations in terms of project delivery, and about the effectiveness of projects funded. Beliefs about the behaviour and beliefs of others (subjective norms), on the other hand, are not included due to theoretically-predicted stand-alone impact on behaviour (theory of planned behaviour – Ajzen, 1991).

The principal component analysis was run in SPSS. Based on Bartlett's test of sphericity we can reject the null hypothesis that variables are orthogonal ($p<0.01$), whilst the Kaiser-Meyer-Olkin measure of sampling adequacy was above the threshold of 0.5 (value of 0.633), both confirming that this data reduction technique is suitable to use on the dataset. Here, too, the principal component analysis was based on the correlation matrix and specified the retention of eigenvalues over 0.5.

Based on the results, two factors were combined into one component: trust in voluntary carbon offset organisations and belief in their project output efficacy (see rotated component matrix in Table 18). The remaining two factors – self-efficacy and sense of personal responsibility – were revealed to be independent and were treated as such for hypothesis testing. The four variables explain 94% of the variance in the data (Table 19). Correlations

between the variables are below 0.5 (Table 20), indicating that a higher eigenvalue cut-off may create components based on spurious commonalities.

Since the statements in the survey that captured trust ("Voluntary carbon offsets will reduce carbon emissions elsewhere through VCO projects") and belief in project output efficacy ("Projects funded through VCOs will positively impact the environment") were also similar in terms of content, their consolidation into one variable was not considered damaging to result interpretation but did succeed in marginally reducing data dimensionality.

Table 18: Beliefs - rotated component matrix

Component	1	2	3
Trust in voluntary carbon offsets	0.922		
Belief in output efficacy	0.907		
Personal responsibility		0.964	
Self-efficacy			0.998

Source: author's own

Table 19: Beliefs – variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Compo-nent	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.119	52.974	52.974	2.119	52.974	52.974	1.744	43.589	43.589
2	0.985	24.633	77.607	0.985	24.633	77.607	1.012	25.306	68.895
3	0.654	16.352	93.959	0.654	16.352	93.959	1.003	25.064	93.959
4	0.242	6.041	100.000						

Source: author's own

Table 20: Beliefs – correlation matrix

	Personal responsibility	Trust in VCOs	Belief in output efficacy	Self-efficacy
Personal responsibility	1.000	0.425	0.448	0.075
Trust in VCOs	0.425	1.000	0.756	0.057
Belief in output efficacy	0.448	0.756	1.000	0.103
Self-efficacy	0.075	0.057	0.103	1.000

Source: author's own

Test for multi-collinearity

One of the key assumptions of regression is linear independence between the explanatory variables. Since the regression coefficient represents the mean change in the dependent variable for each unit change in an independent variable when you hold all of the other independent variables constant, this ceteribus paribus condition becomes difficult when these are strongly correlated. Multi-collinearity can be diagnosed with the Variance inflation factor (VIF). VIF is calculated by regressing each predictor against every other predictor in the model (giving R^2 values), subtracting this from 1, and inverting the result: $VIF_i = \frac{1}{1-R_i^2}$. If

$VIF_i = 0$, there is no correlation between variable *i* and other variables; the higher the value of VIF, the greater the correlation to other variables. A VIF value over 10 indicates strong collinearity and is considered problematic by most standards (e.g. James et al., 2013), and any value over 2.5 indicates considerable collinearity (Johnston et al., 2017).

Though multi-collinearity does not reduce the predictive power or reliability of the model as a whole, it may affect the predictive power and thus interpretation of any (continuous) control variables.

To obtain the VIF, a linear regression was conducted on attitude with all (non-socio demographic) continuous control variables selected as the independent variables in the model, and collinearity diagnostics and correlation matrix as outputs of the analysis. The collinearity statistics are provided in Table 21 below. Two sets of collinearity statistics are provided: of the regression on all original variables (a) and of the regression on the variables after principal component analysis (b). As can be seen from the second column, the VIF for trust in carbon offsets and belief in output efficacy both exceed 2.5, but drop to 1.5 when combined under an umbrella variable. The VIF of green identity and green behaviour was below the threshold of concern, but was higher than the rest; the combined variable's VIF value fell to 1.85. All final predictors for the model have a variance inflation factor below the most conservative threshold of 2.5, indicating adequate independence between the variables.

Table 21: Multi-collinearity diagnostics

	Collinearity Statistics (a)		**Collinearity Statistics (b)**	
	Tolerance	**VIF**	**Tolerance**	**VIF**
Personal responsibility	0.571	1.751	0.574	1.743
Belief - trust in VCOs	0.384	2.606	/	/
Belief in output efficacy	0.374	2.672	/	/
Beliefs2	/	/	0.634	1.576
Self-efficacy	0.949	1.054	0.955	1.047
Social norms	0.627	1.596	0.628	1.593
Value orientation: egoistic	0.914	1.094	0.919	1.088
Value orientation: altruistic	0.577	1.734	0.582	1.719
Value orientation: biospheric	0.459	2.180	0.463	2.161
Green identity	0.470	2.128	/	/
Green behaviour	0.479	2.086	/	/
Green2	/	/	0.540	1.850
Involvement of green movement	0.667	1.498	0.674	1.484
Donate to env causes	0.672	1.488	0.674	1.484
Environment-economy tradeoff	0.573	1.746	0.575	1.740
Familiarity with VCOs	0.904	1.106	0.914	1.094
Frequency of flying	0.939	1.065	0.942	1.061

Source: author's own

4.3.3 Treatment effects on attitude

An analysis of framing effects on attitude was conducted first in order to confirm the most suitable method for analysing the (study's main) framing effects on behaviour. Since the experimental treatment could influence behaviour both directly and indirectly through attitude, a path analysis could be more appropriate.

In the survey, participants expressed their attitude towards voluntary carbon offsetting by indicating their position on three statements, measured on a 6-point Likert scale (see Chapter 3.5.2 Measurement instruments). The mean score of the three items is the attitude variable. The analysis of carbon offsetters notwithstanding, attitude was thus treated as a continuous variable for identifying treatment effects. An alternative analysis, treating attitude as a dichotomous nominal variable, is provided below.

Linear regression on attitude

I run a univariate linear regression of treatment effects on attitude, represented in the following model:

$$Y_{att,i} = \beta_0 + \beta_{treat} X_{treat,i} + \varepsilon_i \qquad [1.1]$$

Y_{att} denotes attitude towards voluntary carbon offsetting, X_{treat} is the treatment, and β_0 and β_{treat} are the parameters to be estimated. The results showed that neither the loss nor the gain treatment, when compared to the benchmark group with no frame, has a statistically significant effect on attitudes, even when not controlling for any other variables (Table 22). This implies that the univariate regression model has a poor fit, also shown as a very low adjusted R squared value of 0.007.

Table 22: Univariate linear regression of treatment on attitude

Att	**Coef.**	**Std. Err**	**t**	**P>|t|**	**95% Conf.**	
Constant	3.643**	0.092	39.73	0.000	3.463	3.823
Treatment						
Gain	-0.092	0.130	-0.71	0.476	-0.347	0.162
Loss	0.200	0.130	1.54	0.124	-0.055	0.455
Summary statistics						
Observations	465					
F(2, 462)	2.66					
Prob > F	0.071					
R-squared	0.011					
Adj R-squared	0.007					
Root MSE	1.14					

** Significant at p < 0.05, ** significant at p < 0.01.*
Source: author's own

As a next step, I therefore estimate treatment and treatment-interaction effects when controlling for the variables that may impact attitudes towards voluntary carbon offsetting, independent of the treatment.

The following multivariate linear regression model is estimated:

$$Y_{att,i} = \beta_0 + \beta_{treat} X_{treat,i} + \beta_2 X_{2,i} + \cdots + \beta_{23} X_{23,i} \quad [1.2]$$

As before, Y_{att} is attitude and X_{treat} is the treatment, whilst X_2-X_{23} are the 22 remaining control variables after principal component analysis. With a sample size of 465 and 22 control variables, the risk of overfitting the model remains. One method for narrowing down the number of variables in the final model is stepwise regression. This is an automatic computational procedure that seeks to identify the 'best' model by iteratively removing (backward stepwise) or adding (forward stepwise) variables. However, due to its artificiality, stepwise regression as a method for model optimisation has fallen under intense critique and calls to avoid it altogether (e.g. Smith, 2018). Another problem is that it may exclude theoretically important variables that are not statistically significant; this absence of a result may be meaningful in itself. I lean on both theory and empirical evidence in specifying the final model, keeping the variables that show a significant effect in the entire model as well as those that have been predicted to have an effect on pro-environmental decisions in the literature (see Chapters 2.4.5 and 3.5.3). The optimised model is shown in Table 23. For the final model I removed variables whose statistical significance exceeded the 10% upper bound and which were not featured in theory[14]. The results of the model with all 24 independent variables are shown in Appendix 7.

The model predicts attitudes reasonably well (adjusted R-squared 0.48). Neither the gain nor the loss message frame had a statistically significant effect on an individual's attitude towards voluntary carbon offsetting. The following four variables did have a statistically significant effect on attitude at the 1% level: 'beliefs2' ($\beta = 0.281$; $t = 5.90$); subjective norms ($\beta = 0.278$; $t = 7.21$); position on the environment-economy trade–off ($\beta = 0.267$; $t = 5.69$); and the respondent's gender ($\beta = -0.213$; $t = -2.61$). Past purchase of voluntary carbon offsets ($\beta = 0.227$; $t = 2.38$) and part time employment ($\beta = 0.266$; $t = 2.17$) were positively correlated with attitude towards carbon offsetting, which was statistically significant at the 5% level.

[14] The variables that do not feature in the final model are: membership of green movement, past donation to environmental goods, familiarity with voluntary carbon offsetting, frequency of flying, Covid-19 impact, as well as age, income, number of children, political orientation and education level.

Table 23: Multivariate linear regression of treatment on attitude

	Coef.	Std. Err	t	P>|t|	95% Conf.	
Constant	-0.035	0.299	-0.12	0.908	-0.623	0.554
Treatment (base=control)						
Gain	-0.037	0.095	-0.38	0.701	-0.224	0.151
Loss	0.045	0.095	0.47	0.639	-0.142	0.231
Personal responsibility	0.051	0.045	1.15	0.252	-0.037	0.140
Beliefs2	0.281	0.048	5.90	0.000	0.187	0.374
Self-efficacy	0.042	0.033	1.27	0.204	-0.023	0.108
Subjective norms	0.278	0.039	7.21	0.000	0.202	0.353
Egoistic value orient.	-0.015	0.028	-0.54	0.588	-0.069	0.039
Altruistic value orient.	0.061	0.033	1.85	0.064	-0.004	0.126
Biospheric value orient.	0.009	0.038	0.23	0.817	-0.066	0.083
Green lifestyle	-0.093	0.059	-1.59	0.112	-0.208	0.022
Env-econ trade-off	0.267	0.047	5.69	0.000	0.175	0.359
Past purchase of VCOs	0.227	0.095	2.38	0.018	0.039	0.415
Gender (male)	-0.213	0.082	-2.61	0.009	-0.374	-0.052
Employment status (base=full time)						
Part time employed	0.266	0.123	2.17	0.030	0.026	0.507
Self-employed	-0.066	0.134	-0.50	0.621	-0.329	0.196
Unemployed	0.032	0.175	0.18	0.857	-0.313	0.376
Other	-0.105	0.122	-0.85	0.394	-0.345	0.136

Summary statistics	
Sample size	465
Prob > F	0.000
R-squared	0.500
Adjusted R-squared	0.480
Root MSE	0.826

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Two slight adjustments to the model must be made explicitly at this point. The first is the relationship between attitude and behaviour. Since the former temporarily and psychologically precedes the latter, for conditions of causality, attitude can cause behaviour but not be caused by it. However, where attitude questions follow the offsetting decision, responses may indeed be influenced by this decision due to consistency bias. With a view to determine whether there is an effect of behaviour *on* attitude I run a linear regression model with interaction effects between behaviour and survey order as an independent variable. Results, shown in Table 24, confirm that there is no statistically significantly different relationship between behaviour and attitude across the two survey orders. It follows that behaviour did not affect attitude.

Table 24: Behaviour effect on attitude

	Coef.	Std.Err	t	P>|t|	95% Conf.	
Treatment						
Gain	-0.053	0.127	-0.42	0.675	-0.303	0.196
Loss	0.182	0.127	1.43	0.153	-0.068	0.431
Behaviour (base=yes) * Surveyorder (base=beh-att)						
No*beh-att	-0.530**	0.147	-3.60	0.000	-0.820	-0.241
No*att-beh	-0.505**	0.145	-3.47	0.001	-0.790	-0.219
Yes*att-beh	0.089	0.168	0.53	0.597	-0.241	0.418
_cons	3.939	0.137	28.700	0.000	3.669	4.208
Behaviour (base=no) * Surveyorder (base=beh-att)						
No*att-beh	0.026	0.132	0.19	0.846	-0.234	0.285
Yes*beh-att	0.530**	0.147	3.60	0.000	0.241	0.820
Yes*att-beh	0.619**	0.156	3.97	0.000	0.313	0.925
Constant	3.408	0.117	29.040	0.000	3.178	3.639

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Second, I include an interaction effect between survey order and treatment. An implicit assumption in the experiment is that the randomisation of survey order succeeded in minimising common method bias without an effect on the outcome. This can be verified by analysing the two subsets of the data, split across survey order, separately, or by including an interaction effect in the model. Opting for the latter, I include interaction effects between survey order and treatment (Table 25). As columns 3 and 4 show, once other variables are controlled for, there is no interaction effect between survey order and treatment.

Table 25: Multivariate linear regression of treatment on attitude - 4 model variations

	Model (A)			Model (B): Model A with behaviour effect			Model (C): Model A with interaction effect			Model (D): Model A with behaviour and interaction effects		
	Coef.	**Std. Err**	**t**	**Coef.**	**Std. Err**	**t**	**Coef.**	**Std. Err**	**t**	**Coef.**	**Std. Err**	**t**
Constant	-0.035	0.299	-0.12	-0.015	0.299	-0.05	-0.050	0.309	-0.16	-0.024	0.308	-0.08
Treatment (base=control)												
Gain	-0.037	0.095	-0.38	-0.028	0.095	-0.30	0.001	0.132	0.01	-0.005	0.131	-0.04
Loss	0.045	0.095	0.47	0.040	0.095	0.42	-0.061	0.133	-0.46	-0.090	0.134	-0.68
Behaviour				0.169	0.083	2.03*				0.185	0.084	2.21*
Personal responsibility	0.051	0.045	1.15	0.052	0.045	1.17	0.050	0.045	1.11	0.051	0.045	1.13
Beliefs2	0.281	0.048	5.9**	0.270	0.048	5.66**	0.280	0.048	5.87**	0.268	0.048	5.63**
Self-efficacy	0.042	0.033	1.27	0.042	0.033	1.28	0.047	0.034	1.39	0.047	0.033	1.40
Subjective norms	0.278	0.039	7.21**	0.280	0.038	7.29**	0.270	0.039	6.95**	0.271	0.039	7.00**
Egoistic value orient.	-0.015	0.028	-0.54	-0.009	0.028	-0.32	-0.016	0.028	-0.57	-0.009	0.028	-0.33
Altruistic value orient.	0.061	0.033	1.85	0.063	0.033	1.91	0.065	0.033	1.97	0.068	0.033	2.05*
Biospheric value orient.	0.009	0.038	0.23	0.003	0.038	0.07	0.007	0.038	0.18	0.000	0.038	0.00
Green lifestyle	-0.093	0.059	-1.59	-0.088	0.058	-1.50	-0.087	0.059	-1.48	-0.080	0.059	-1.36
Env-econ trade-off	0.267	0.047	5.69**	0.250	0.047	5.28**	0.267	0.047	5.7**	0.249	0.047	5.26**
Past purchase of VCOs	0.227	0.095	2.38*	0.223	0.095	2.35	0.224	0.096	2.34*	0.220	0.095	2.32*
Gender (male)	-0.213	0.082	-2.61*	-0.210	0.082	-2.58*	-0.213	0.082	-2.60*	-0.208	0.082	-2.55*
Employment status (base=full time)												
Part time employed	0.266	0.123	2.17*	0.246	0.123	2.00*	0.268	0.123	2.18*	0.244	0.123	1.99*
Self-employed	-0.066	0.134	-0.50	-0.078	0.133	-0.59	-0.057	0.134	-0.43	-0.070	0.134	-0.52
Unemployed	0.032	0.175	0.18	0.050	0.175	0.29	0.024	0.176	0.14	0.042	0.175	0.24
Other	-0.105	0.122	-0.85	-0.096	0.122	-0.79	-0.097	0.123	-0.79	-0.090	0.122	-0.73
Treatment * Survey order												
Control * att-beh							0.008	0.135	0.06	-0.007	0.135	-0.05
Gain * att-beh							-0.077	0.134	-0.57	-0.061	0.134	-0.46
Loss * att-beh							0.221	0.135	1.64	0.255	0.135	1.88

(Table continues)

Table 25: Multivariate linear regression of treatment on attitude - 4 model variations (cont.)

		Model (A)		Model (B): Model A with behaviour effect		Model (C): Model A with interaction effect		Model (D): Model A with behaviour and interaction effects
Summary statistics								
Sample size		465		465		465		465
F (,)	(18,446)	24.77	(19,445)	23.85	(21,443)	21.38	(22,442)	20.80
Prob > F		0.000		0.000		0.000		0.000
R-squared		0.500		0.505		0.503		0.509
Adjusted R-squared		0.480		0.483		0.480		0.484
Root MSE		0.826		0.823		0.826		0.823

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Logistic regression on attitude

Attitude may also be interpreted as a binary construct: an individual may hold either a positive or negative attitude towards an environmental behaviour or outcome. It is worth verifying whether this transformation impacts the potential treatment effect on attitudes. This assessment follows the offsetter profile analysis in treating attitude as a dummy variable, coding 0 for negative (paying for voluntary carbon offsets is 'very' to 'somewhat' unpleasant, unreasonable or ineffective use of money) and 1 for positive (from 'somewhat' to 'very' pleasant, reasonable and effective use of money). The output of the reduced model is shown in Table 26 (the output with coefficients can be found in Appendix 8). Results confirm that treatment did not affect whether the participant had (or expressed) a positive or negative attitude.

Table 26: Logistic regression of treatment on attitude – marginal effects

	dy/dx	Std. Err	z	P>|z|	95% Conf.	
Treatment						
Gain	-0.034	0.046	-0.75	0.451	-0.124	0.055
Loss	-0.004	0.045	-0.09	0.927	-0.093	0.084
Personal responsibility	-0.011	0.023	-0.49	0.622	-0.056	0.033
Beliefs	0.099	0.022	4.47**	0.000	0.056	0.143
Self efficacy	0.027	0.017	1.63	0.103	-0.005	0.059
Subjective norms	0.100	0.017	5.75**	0.000	0.066	0.134
Egoistic value orient.	0.019	0.014	1.40	0.160	-0.008	0.046
Altruistic value orient.	0.037	0.016	2.28*	0.022	0.005	0.068
Biospheric value orient.	-0.018	0.018	-0.99	0.321	-0.054	0.018
Green lifestyle	-0.043	0.029	-1.47	0.142	-0.100	0.014
Env-econ trade-off	0.110	0.021	5.30**	0.000	0.069	0.150
Past purchase	0.181	0.055	3.32**	0.001	0.074	0.288
Gender (male)	-0.051	0.040	-1.27	0.203	-0.128	0.027
Employment						
Part time employed	0.076	0.058	1.32	0.186	-0.037	0.189
Self-employed	-0.037	0.065	-0.57	0.570	-0.166	0.091
Unemployed	0.014	0.080	0.17	0.864	-0.144	0.171
Other	-0.021	0.060	-0.35	0.726	-0.139	0.097
Summary statistics						
Sample size	465					
LL	-218.398					
LR Chi2 (18)	199.270					
Prob>chi2	0.000					
Pseudo R2 (McFadden)	0.313					
Akaike IC	474.796					

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Since the results presented in Table 25 and Table 26 show that there is no statistically significant treatment effect on attitudes, I reject Hypothesis 1 of my study.

4.3.4 Treatment effects on behaviour

The linear regression showed the framing treatment to have no statistically significant effect on attitude; therefore, a simple binary logistic regression was considered appropriate for determining treatment effects on behaviour.

A logit analysis was conducted to determine the effect of loss or gain framing on the likelihood of purchasing a voluntary carbon offset within the experiment. To this end, I ran the following logistic regressions:

$$\Pr[Y_{beh,i} = 1|X] = e^{(\beta_0 + \beta_{treat}X_{treat,i})} / 1 + e^{(\beta_0 + \beta_{treat}X_{treat,i})} \quad [2.1]$$

$$\Pr[Y_{beh,i} = 1|X] = \frac{e^{(\beta_0+\beta_{treat}X_{treat,i}+ \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}}{1+e^{(\beta_0+\beta_{treat}X_{treat,i}+ \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}} \quad [2.2]$$

$$\Pr[Y_{beh,i} = 1|X] = \frac{e^{(\beta_0+\beta_{treat}X_{treat,i}+ \beta_2X_{2,i}+\cdots+ \beta_{24}X_{24,i})}}{1+e^{(\beta_0+\beta_{treat}X_{treat,i}+ \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}} \quad [2.3]$$

$$\Pr[Y_{beh,i} = 1|X] = \frac{e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{24}X_{24,i} + \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}}{1+e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{24}X_{24,i} + \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}} \quad [2.4]$$

$$\Pr[Y_{beh,i} = 1|X] = \frac{e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{12}X_{12,i})}}{1+e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{12}X_{12,i})}} \quad [2.5]$$

$$\Pr[Y_{beh,i} = 1|X] = \frac{e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{12}X_{12,i} + \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}}{1+e^{(\beta_0+\beta_{treat}X_{treat,i}+\beta_2X_{2,i}+\cdots+\beta_{12}X_{12,i} + \beta_{order}X_{order,i}+ \beta_{26}X_{treat,i}X_{order,i})}} \quad [2.6]$$

The dependent variable in this model is the probability that Y_{beh} (behaviour, i.e. the allocation of task earnings to a voluntary carbon offset), assumes a value of 1. Variable X_{treat} is the treatment and variables $X_{2\text{-}24}$ are control variables, with variable X_{order} capturing survey order. The first two equations represent a univariate analysis of framing on behaviour; equations 2.3-2.4 present the model with the entire set of control variables; and the final two equations specify the reduced model. Equations 2.2 (for the univariate analysis), 2.4 (for the full model) and 2.6 (for the final reduced model) include interaction effects between survey order and treatment (as well as the survey order main effect, as per good practice).

A univariate analysis identified no statistically significant treatment effects on behaviour (Model A in Table 27). Including the interaction effect between survey order and treatment does, however, yield an interesting result (Model B in Table 27). Without controlling for other variables, loss framing in the behaviour-first survey order almost doubles the odds of

purchasing a voluntary carbon offset compared to the control (β = 0.651; z = 1.99). By extension, for the loss frame, reading questions on attitudes first led to a lower likelihood of purchasing a carbon offset when compared to the opposite survey order ($p<0.05$).

Dividing the dataset into two subsets according to survey order makes the results clearer. When the participants were led straight to the real effort task and behaviour decision, the loss-framed description of voluntary carbon offsets led to a statistically higher likelihood of purchasing an offset ($p<0.05$). More precisely, the loss frame was associated with a 15.8 percentage point higher probability of purchasing an offset (Model A.1 in Table 28). This effect disappeared when the participants were asked to first fill in the questionnaire, including questions on their attitude towards offsetting.

Table 27: Univariate logistic regression of treatment on behaviour – coefficients

	Model A: univariate [2.1]				**Model B: univariate with survey order interaction [2.2]**			
	Coef.	**z**	**P>|z|**	**Odds ratio**	**Coef.**	**z**	**P>|z|**	**Odds ratio**
Constant	-0.432	-2.63	0.009	0.649	-0.600	-2.55	0.011	0.549
Treatment (0=control)								
Gain	-0.280	-1.18	0.238	0.756	0.089	0.27	0.788	1.093
Loss	0.160	0.69	0.489	1.173	0.651*	1.99	0.046	1.917
Survey order: att-beh					0.335	1.02	0.310	1.398
Treatment * Survey order								
Gain*att-beh					-0.769	-1.61	0.108	0.464
Loss*att-beh					-1.002*	-2.15	0.031	0.367
Summary statistics								
Observations				465				465
LR chi2 ( )			(2)	3.58			(5)	10.38
Prob > chi2				0.167				0.065
Cox & Snell R Square				0.01				0.02
Nagelkerke R Square				0.10				0.03
Akaike IC				622.2				621.4
Bayesian IC				634.6				646.3

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

The gain frame, by contrast, was associated with a lower likelihood of purchasing a voluntary carbon offset within the experiment when the attitude questions appeared before the behaviour decision. Participants in the gain treatment who saw this survey order were 15.4 percentage points less likely to purchase an offset than the participants in the control group.

Table 28: Univariate logistic regression of treatment on behaviour, split by survey order – marginal effects

	Model A.1: beh-att dataset				Model A.2: att-beh dataset			
	dy/dx	**Std.error**	**z**	**P>|z|**	**dy/dx**	**Std.error**	**z**	**P>|z|**
Treatment								
Gain	0.021	0.076	0.27	0.788	-0.154	0.077	-2.00*	0.045
Loss	0.158	0.078	2.03*	0.043	-0.084	0.079	-1.06	0.288
Summary statistics								
Observations				237				228
LR chi2 ( )			(2)	4.77			(2)	3.94
Prob > chi2				0.092				0.139
McFadden pseudo R square				0.015				0.013
Cox & Snell R Square				0.027				0.02
Akaike IC				322.7				298.8
Bayesian IC				333.1				309.0

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

What remains is to diagnose whether these effects persist when other factors that could influence the offsetting decision are controlled for. Adopting the same approach as before, I conducted a manual iterative regression to arrive at a reduced model with better goodness-of-fit scores. The condensed model includes variables that are either statistically significant in the full model (equation 2.3) or predicted by theory to be so. Since the absence of statistical significance is a valuable result in itself, especially where it contradicts prior theory and literature, it was important to not exclude them from the model, even at the cost of poorer fit. Survey order and its interaction with treatment were also included, since it showed to be significant in the univariate model. I then calculated marginal effects to quantify the difference in the probability of offsetting between the treatment groups.

The output of model 2.6 with coefficients is provided in Table 29. The output of the full model (equation 2.3) with all 23 control variables, together with its extension including interaction effects with survey order, is presented in Appendix 10. Table 30 presents the marginal effects of the treatments and control variables on behaviour, and Table 31 divides this across the two survey orders.

The model as a whole fits the data well ($p<0.00$). Unlike for linear regression, there is no optimal criterion for assessing the goodness of fit of a logistic regression model. Instead, we can compare different models to see which one fits the data better. The value of the Hosmer and Lemeshow test statistic is above the critical level of 0.05; we can reject the null hypothesis that observed values do not match expected values in subgroups of the model population. Model 2.6 performs better than the univariate model in terms of the value of McFadden pseudo R square statistic, but worse than the full model (2.4). To take into account model complexity, I turn to information criteria (IC), which penalise overfitting the model.

The Akaike and Bayesian IC can both be used to find the model that explains the greatest amount of variation using the fewest explanatory variables (Stoica and Selen, 2004). The value of the Akaike IC of 579.9 makes this reduced model better performing than the univariate logistic regression (value of 622.2) and the full model (594.5).

Table 29: Multivariate logistic regression of treatment on behaviour – coefficients

	Coef.	Std. Err	z	P>|z|	95% Conf.		Odds ratio
Constant	-3.287	0.765	-4.30	0.000	-4.786	-1.788	0.037
Treatment							
Gain	0.180	0.356	0.51	0.613	-0.518	0.878	1.198
Loss	0.791	0.357	2.22*	0.027	0.091	1.491	2.205
Survey order: att-beh	0.457	0.359	1.27	0.203	-0.247	1.160	1.579
Treatment*survey order							
Gain*att-beh	-0.794	0.515	-1.54	0.123	-1.804	0.215	0.452
Loss*att-beh	-1.347	0.511	-2.64**	0.008	-2.349	-0.345	0.260
Attitude	0.322	0.126	2.55*	0.011	0.074	0.569	1.379
Personal responsibility	-0.030	0.126	-0.24	0.813	-0.277	0.217	0.971
Beliefs2	0.210	0.137	1.54	0.124	-0.058	0.477	1.233
Subjective norms	-0.076	0.112	-0.68	0.495	-0.296	0.143	0.926
Egoistic value orient.	-0.145	0.076	-1.92	0.055	-0.293	0.003	0.865
Altruistic value orient.	-0.087	0.089	-0.98	0.325	-0.262	0.087	0.916
Biospheric value orient.	0.218*	0.105	2.08*	0.038	0.013	0.423	1.243
Green lifestyle	-0.033	0.172	-0.19	0.848	-0.370	0.304	0.968
Involved in movement	-0.023	0.108	-0.21	0.830	-0.235	0.189	0.977
Past donation	-0.300	0.102	-2.94**	0.003	-0.500	-0.100	0.741
Env-econ trade-off	0.462	0.135	3.41**	0.001	0.197	0.727	1.587
Summary statistics							
Observations	465						
Log-likelihood	-272.931						
LR chi2 (16)	73.920						
Prob > chi2	0.000						
McFadden pseudo R square	0.119						
Cox & Snell R Square	0.147						
Nagelkerke R Square	0.200						
Akaike IC	579.862						
Bayesian IC	650.270						

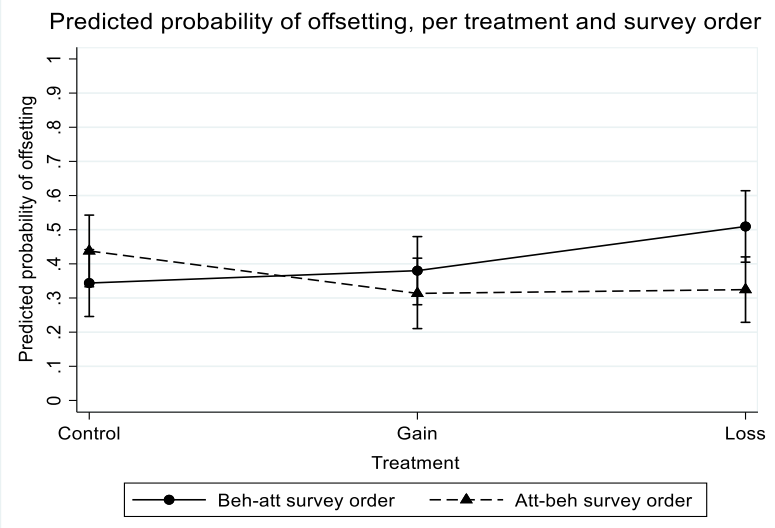
** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

The loss frame had the predicted positive effect on behaviour at the 5% significance level ($\beta = 0.791$, $z = 2.22$) only in the survey order, in which the real effort task and subsequent decision on behaviour immediately followed the framed description and preceded the questions on attitudes. In terms of the marginal effects, loss framing was associated with a 17.1 percentage point higher likelihood of offsetting in this dataset compared to the

benchmark. Turning to the model with interaction effects (model 2.6), the predicted probability of offsetting in the loss treatment group is calculated to be 50.1%, in the gain treatment group 38%, and in the control group it is 34.4% (Table 32 and Figure 18; an alternative visualisation is provided in Appendix 11).

Figure 18: Predicted probability of purchasing a voluntary carbon offset, per treatment and survey order



Source: author's own

Table 30: Multivariate logistic regression of treatment on behaviour - marginal effects – model 2.6

	dy/dx	Std.error	z	P>|z|	[95% Conf.	Interval]
Treatment						
Gain	-0.042	0.052	-0.82	0.412	-0.144	0.059
Loss	0.029	0.052	0.56	0.578	-0.072	0.130
Attitude	0.065	0.025	2.61**	0.009	0.016	0.113
Personal responsibility	-0.006	0.025	-0.24	0.813	-0.056	0.044
Beliefs	0.042	0.027	1.55	0.121	-0.011	0.096
Subjective norms	-0.015	0.023	-0.68	0.494	-0.059	0.029
Egoistic value orient.	-0.029	0.015	-1.95	0.051	-0.059	0.000
Altruistic value orient.	-0.018	0.018	-0.99	0.324	-0.053	0.017
Biospheric value orient.	0.044	0.021	2.12*	0.034	0.003	0.084
Green lifestlye	-0.007	0.035	-0.19	0.848	-0.074	0.061
Member of movement	-0.005	0.022	-0.21	0.830	-0.047	0.038
Past donation	-0.060	0.020	-3.05**	0.002	-0.099	-0.022
Env-econ trade-off	0.093	0.026	3.57**	0.000	0.042	0.144

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Hypothesis 2 is thus only partially supported: loss framing was effective subject to a behaviour-then-attitude survey order. Neither the loss nor the gain framed messages, when

compared to the no-frame baseline, had a statistically significant effect in the survey order, in which questions on attitude preceded the behaviour decision. By extension, within the loss treatment group, the attitude-then-behaviour survey order was associated with a lower propensity to offset at the 1% significance level (β = -1.347, z = -2.64). Table 30 also shows that whilst the gain frame had a statistically significant (5% level) negative effect on offsetting in the attitude-first survey order in the univariate analysis (Table 28), this effect lost its statistical significance once other variables are controlled for.

Table 31: Multivariate logistic regression of treatment on behaviour – marginal effects – split across survey orders

	Model A.1: beh-att dataset				**Model A.2: att-beh dataset**			
	dy/dx	**Std.error**	**z**	**P>|z|**	**dy/dx**	**Std.error**	**z**	**P>|z|**
Treatment								
Gain	0.043	0.070	0.60	0.546	-0.125	0.075	-1.66	0.096
Loss	0.171	0.072	2.37*	0.018	-0.121	0.075	-1.62	0.106
Attitude	0.057	0.035	1.64	0.102	0.071	0.036	1.99	0.047
Personal responsibility	-0.023	0.036	-0.65	0.517	0.004	0.036	0.10	0.918
Beliefs	0.042	0.038	1.12	0.261	0.049	0.040	1.23	0.220
Subjective norms	-0.028	0.030	-0.93	0.351	-0.004	0.034	-0.11	0.914
Egoistic value orient.	-0.035	0.020	-1.74	0.083	-0.027	0.022	-1.20	0.232
Altruistic value orient.	-0.025	0.023	-1.07	0.283	0.005	0.029	0.16	0.875
Biospheric value orient.	0.071	0.028	2.54*	0.011	0.006	0.031	0.20	0.838
Green lifestlye	-0.038	0.047	-0.80	0.424	0.045	0.051	0.87	0.383
Member of movement	0.000	0.029	0.02	0.987	-0.017	0.033	-0.52	0.602
Past donation	-0.059	0.026	-2.29*	0.022	-0.063	0.031	-2.04*	0.041
Env-econ trade-off	0.129	0.035	3.64**	0.000	0.048	0.039	1.25	0.212

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Table 32: Predicted probabilities of purchasing a voluntary carbon offset (model 2.6), by treatment and survey order

Treatment*order interaction	**Margin**	**Std.error**	**z**	**P>|z|**	**[95%**	**Conf.**
control * beh-att	0.344	0.050	6.88	0.00	0.246	0.442
control * att-beh	0.438	0.054	8.18	0.00	0.333	0.543
gain * beh-att	0.380	0.051	7.47	0.00	0.280	0.480
gain * att-beh	0.313	0.053	5.96	0.00	0.210	0.417
loss * beh-att	0.509	0.053	9.54	0.00	0.405	0.614
loss * att-beh	0.325	0.049	6.64	0.00	0.229	0.420

Source: author's own

Looking at this study's response time data we find that the average time a contributor spent on the decision page was 70.3 seconds; the average time was almost 6 seconds longer for a non-contributor. Regression results, however, show no statistically significant effects of response times on behaviour in this study (Appendix 12). I also checked for a possible interaction effect between treatment and response times, but the results were not significant.

The effect of control variables on offsetting behaviour

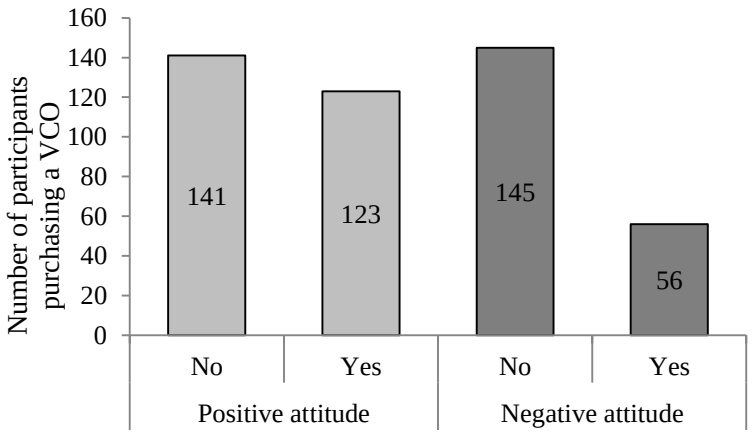
Three additional variables influenced the offsetting decision (Tables 29 and 30): the participant's past donation to environmental causes (β= -0.300; z = -2.94; dy/dx = -6 p.p.), his or her position on the environment-economy trade-off (β = 0.462; z = 3.41; dy/dx = 9.3 p.p.), and biospheric value orientation (β = 0.218; z = 2.08; dy/dx = 4.4 p.p.).

Behaviour-specific beliefs and subjective norms, which were positively correlated with attitudes towards voluntary carbon offsetting, had no statistically significant effect on behaviour, and neither did self-efficacy. Controls for frequency of flying, familiarity with voluntary carbon offsetting, and Covid-19 pandemic impacts on travel did not have a statistically significant effect on the offsetting decision. Finally, behaviour did not differ significantly across socio-demographic characteristics of gender, age, income, education, employment, political orientation and family size.

4.3.5 Relationship between attitude and behaviour

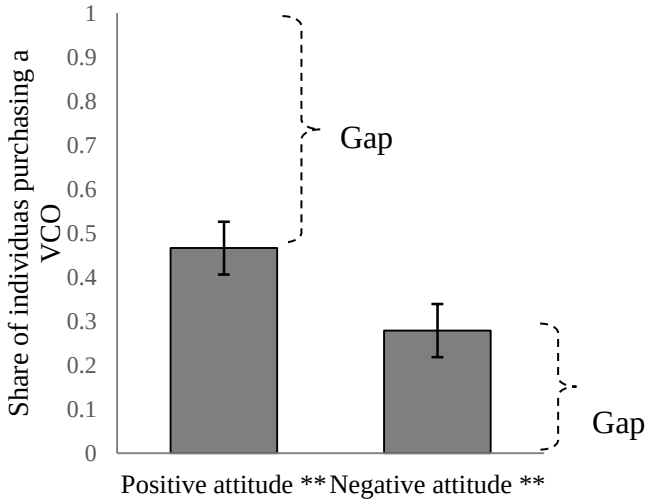
Attitude towards voluntary carbon offsetting had a statistically significant effect on behaviour: for each additional 1-point increase in attitude (on a 6-point Likert scale), the likelihood of purchasing an offset increased by 32% ($p<0.011$). Running a logistic regression of a dichotomous attitude variable on behaviour yields an effect that increases in strength (β = 0.456; z = 1.79), but falls in significance ($p>0.05$). To transform attitude into a binary variable, answers to the three statements representing attitudes towards offsetting on a 6-point Likert scale ("For me to pay for voluntary offsets of my flights would be: …") were divided into two: indicating a value between 1 and 3 represented negative attitude and indicating a value between 4 and 6 represented positive attitude.

Figure 19: Participant behaviour – positive and negative attitude



Source: author's own

Figure 20: Attitude-behaviour gap



*** Significant at p<0.01*

Source: author's own

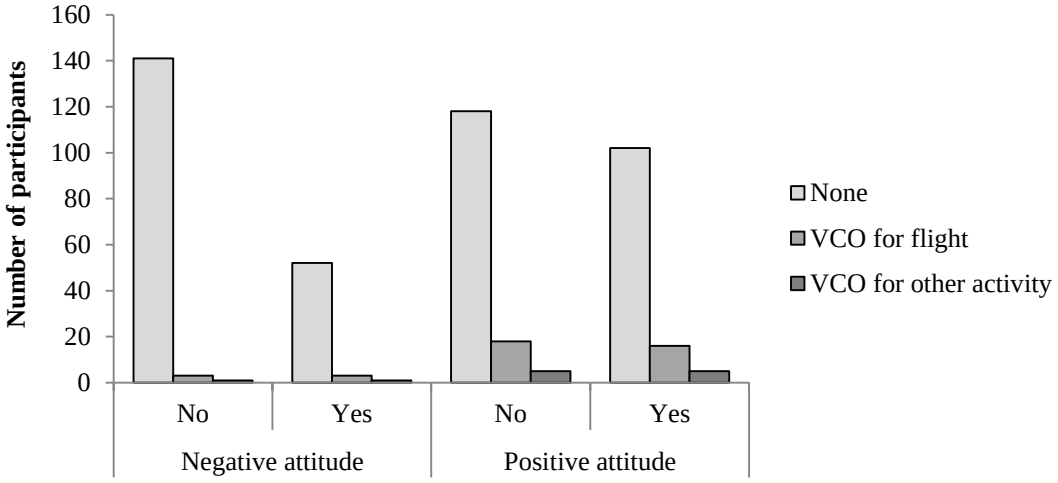
Despite the positive statistically significant effect of attitude on behaviour, there remained a significant gap between positive attitude and corresponding pro-environmental behaviour: 141 participants (53.4%) with a positive attitude towards voluntary carbon offsetting chose to not purchase a voluntary carbon offset within the study (Figure 19). Equivalently, 46.6% of participants with an overwhelmingly positive attitude chose to purchase an offset. A statistical test of proportion confirmed this share to be statistically significantly different from one (first column in Figure 20), which is what would be expected under an assumption of a one-to-one relationship between behaviour and behaviour-specific attitudes.

These results provide support for hypothesis 3a.

It is important to reiterate that although attitude could be a mediator between treatment and behaviour, this dataset did not show this to be the case. Since treatment did not affect attitude (see section 4.3.3 and particularly Table 25), behaviour could not have been affected by the treatment indirectly *through* attitude. Consequently, attitude was included in a logistic regression model as a control variable.

One reason for positive attitudes towards voluntary carbon offsetting not being reflected in offsetting behaviour within the experiment could be that these individuals had already offset a flight. Yet, of the 141 participants who expressed a favourable attitude towards voluntary carbon offsetting, only 16% had offset their flight or other polluting activity in the past and 84% had not done so (Figure 21).

Figure 21: Previous offsetting activity, per attitude and within-study behaviour



Source: author's own

A post-decision question was included to better understand the participants' own subjective reasoning for not purchasing an offset. As shown in Table 33, participants with a positive attitude towards voluntary carbon offsetting were twice as likely to say they did not offset because they "donate to environmental causes through other means" (40% vs. 20%) but less likely to cite absence of trust in offsetting organisations (8% vs. 17%) or in project output efficacy (6% vs. 19%) as reasons for not offsetting, when compared to the participants with a negative attitude.

Table 33: Reasons for not offsetting

	Positive attitude		**Negative attitude**		**Total**	
Reasons for not offsetting	**Count**	**%**	**Count**	**%**	**Count**	**%**
I behave environmentally-friendly in other ways	49	35%	48	33%	97	34%
I donate to environmental causes through other means	56	40%	29	20%	85	30%
I believe it is airlines - not individual passengers – who are responsible for CO2 emitted from flights	31	22%	43	30%	74	26%
I earned the money myself	34	24%	31	21%	65	23%
I do not believe the projects funded through voluntary carbon offsets have the stated or desired effect	9	6%	28	19%	37	13%
I do not trust the organisations that provide voluntary carbon offsets	11	8%	25	17%	36	13%
I do not believe offsetting carbon is necessary	2	1%	7	5%	9	3%
Other	16	11%	13	9%	29	10%
No reasons given	35	25%	39	27%	74	26%
Number of participants	**141**		**145**		**212**	
Total number of reasons provided	243		263		506	
Average reasons given per participant	1.72		1.81		1.77	

Source: author's own

An attitude-behaviour gap was also observed for 56 (28%) respondents who chose to offset their air travel within the experiment, while simultaneously expressing a negative attitude towards this behaviour (Figure 20). As shown with a statistical test of proportion (Figure 21), this number is statistically significantly different from zero, which is what would be expected if pro-environmental (behaviour-specific) attitudes were a pre-requisite for behaviour. Based on predicted probability analysis, Figure 22 also illustrates that the likelihood of purchasing an offset is only marginally lower for those with a negative attitude than for those with a positive attitude.

Asked about their (subjective) reasons for choosing to offset, these participants indicated that it makes them feel good (61%) and that it is the right thing to do (57%), shown in Table 34. More than half of those with a negative attitude towards offsetting indicated it was easier to give away money that was not theirs to begin with, representing a contrast with the 65 participants who did not offset precisely because "they earned the money themselves" (Table 33).

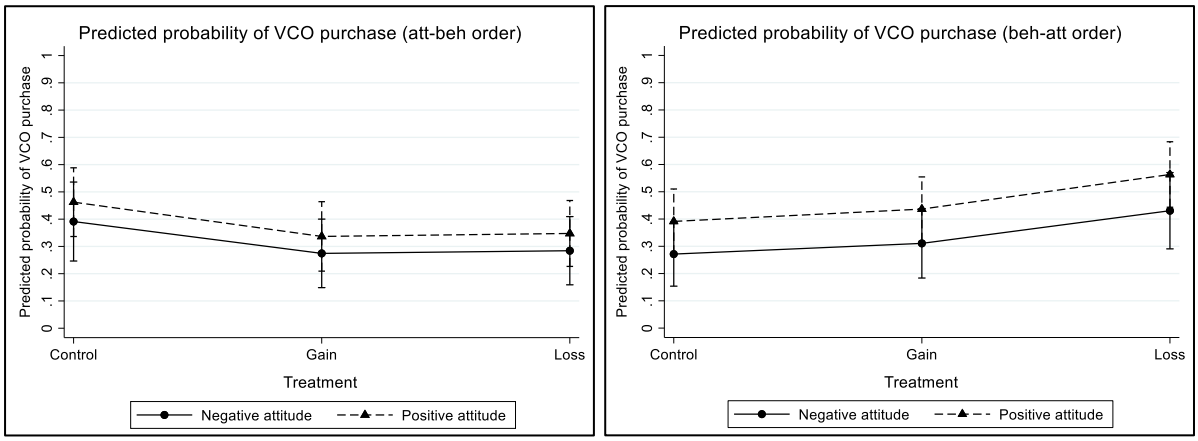
Table 34: Reasons for offsetting

	Positive attitude		**Negative attitude**		**Total**	
Reasons for offsetting	**Count**	**%**	**Count**	**%**	**Count**	**%**
It is the right thing to do	100	81%	32	57%	132	74%
It makes me feel good to give money to environmental causes	80	65%	34	61%	114	64%
It is not my money so it was easier to give away	39	32%	31	55%	70	39%
I would feel guilty if I hadn't purchased a VCO	37	30%	15	27%	52	29%
It ensures the CO2 my flight produced is reduced through another means	30	24%	7	13%	37	21%
I would feel ashamed that I hadn't if somebody asked me	4	3%	3	5%	7	4%
I can feel proud telling I did so to my friends	5	4%	2	4%	7	4%
I do not know	2	2%	2	4%	4	2%
Other	3	2%	1	2%	4	2%
Number of participants	**123**		**56**		**179**	
Total number of reasons proivded	300		127			
Average reasons given per participant	2		2		2	

Source: author's own

Another interesting observation is the difference in the extent of the attitude-behaviour gap across treatments and between the two survey orders. The calculation is visualised in Figure 23. The gain frame combined with attitude-then-behaviour survey order had the highest share of participants with a negative attitude who did not purchase an offset in the study (49%), shown in column 3. In the same survey order, the loss frame condition had the highest number of participants with a positive attitude who did not offset (35, i.e. 45%). The inverse was true for 29 (37%) of participants who read the loss-framed message in the behaviour-then-attitude survey order (column 6).

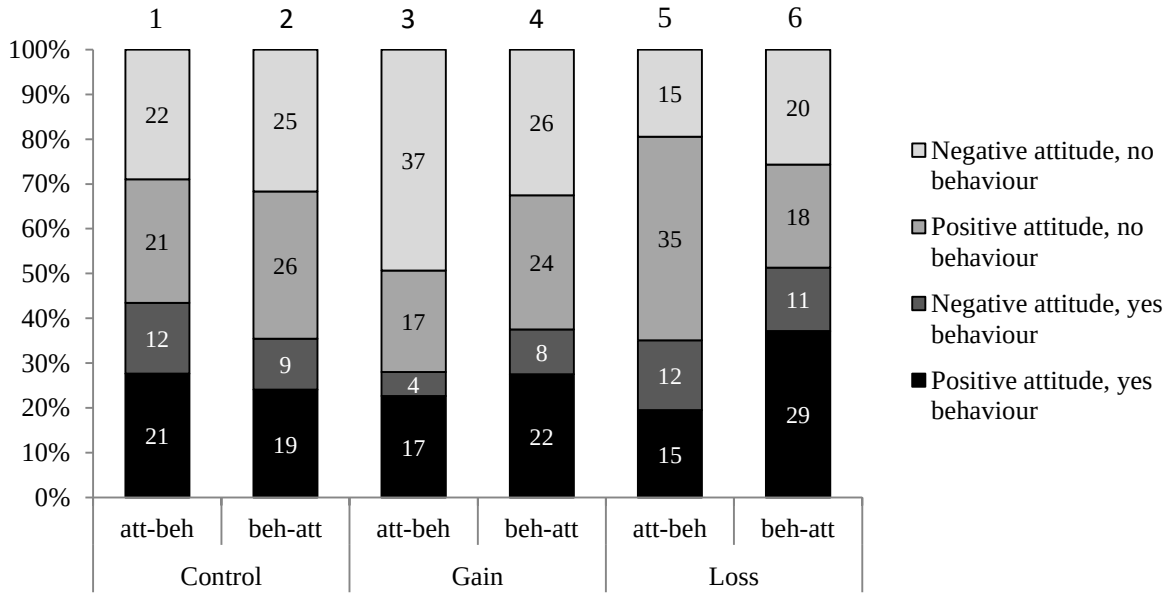
Figure 22: Predicted probability of voluntary carbon offsetting



Source: author's own

I also ran a logistic regression on the dummy variable for attitude-behaviour gap to determine whether the participants whose attitude and behaviour did not match differ significantly across any other socio-demographic, psychographic or other characteristics. The regression output (table in Appendix 13a) shows that participants who indicated that they donated to environmental causes in the past were significantly more likely to exhibit this gap. However, upon deeper examination we can see that this can be attributed to the non-negligible group of participants who simultaneously indicated a negative attitude towards voluntary carbon offsetting, never donated to any environmental ends in the past and decided to not offset within the experiment (Appendix 13b). Other variables did not influence the size of the attitude-behaviour gap.

Figure 23: Relationship between attitude and behaviour, per treatment



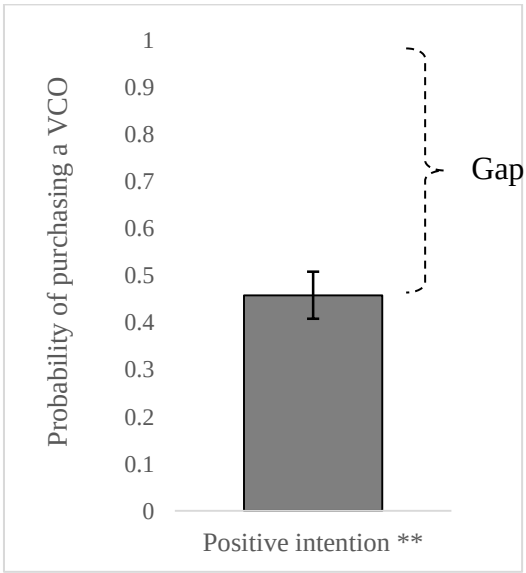
Source: author's own

4.3.6 Relationship between intention and behaviour

In total, 391 (84%) participants in the study expressed an intention to purchase an offset. This was reflected in an agreement to engage in the real effort task, which was in the instructions introduced in a way that suggested the task earnings can go exclusively to one of the chosen voluntary carbon offsetting providers. Once provided with the option to collect the task earnings rather than purchase a voluntary carbon offset, 212 respondents decided to do so. In other words, 54.2% of participants who expressed a positive intention to allocate the task earnings to an offset provider chose not to do so (Figure 24). A one-sample test of proportion indicated this to be statistically significantly different from zero, confirming the presence of a gap between intention to offset and offsetting behaviour. Hypothesis 4, which postulates that a positive intention will not be reflected in commensurate behaviour, is thus supported.

A more advanced analysis was not possible due to complete separation, since a 'no' on intention would by design lead to 'no' on behaviour. The experimental design therefore didn't allow juxtaposing non-intenders and those indicating 'yes' for behaviour, as was done for attitude, since participants' decisions on not wanting to do the task were adhered to. Some studies in the past have done precisely this – in a small meta-analysis of 6 studies, Sheeran (2002) found that of the participants who expressed negative intention, between 0 and 35%, with a median of 7%, carried out the behaviour anyway. However, all of the 6 experiments captured health-related behaviour that was deliberate (cancer screening, exercise) and can thus not be attributed to subconscious processing.

Figure 24: Match between intention and behaviour



*** Significant at p<0.01*

Source: author's own

5 DISCUSSION

5.1 Research findings and discussion

5.1.1 Offsetter profiles

Female participants in the study displayed higher mean attitudes towards voluntary carbon offsetting than their male counterparts. This is in line with findings elsewhere that women are more likely to perceive offsetting messages as credible (Zhang et al., 2019) and show higher willingness to pay for voluntary carbon offsetting (MacKerron et al., 2009). Interestingly, studies in this area rarely measure attitudes, making direct comparison difficult.

When it comes to actual offsetting behaviour, the only socio-demographic variable that was statistically significantly different between offsetters and non-offsetters was political orientation. This reflects findings in the literature that left political ideology is associated with higher likelihood of- or frequency in engaging in pro-environmental behaviour (Klein et al., 2019). The results corroborate the findings of Mair (2011) and Choi and Ritchie (2014), whose analyses of offsetter profiles based on (past reported) voluntary carbon offsetting also did not show a significant relationship with age, gender, income and employment (neither study measured political orientation).

Due to the paucity of research into the intention-behaviour gap, especially across socio-demographic characteristics, it is difficult to contextualise the output of the analysis on the gap between intentions and behaviour across these variables. In terms of political orientation, it appears that those on the right or left of the political spectrum have somewhat clearer and more consistent preferences, whereas those on the centre had positive intentions but these were not strong enough to persist once given the opportunity to collect the task earnings.

Behaviour-specific attitudes were significantly different between the offsetters and the non-offsetters, which is in line with the theory of planned behaviour (Ajzen, 1991) and Choi and Ritchie's (2014) empirical findings. However, they did not predict them perfectly, implying a gap between the two outcome variables, as is expanded on in section 5.1.4.

5.1.2 Treatment effect on attitude

On the next page I present a summary of the hypothesis results in tabular form. I follow with an analysis of the findings, dedicating one section to each hypothesis.

Table 35: Hypothesis summary

Hypothesis number	**Hypothesis**	***Supported?***
1	The *gain-framed* voluntary carbon offsetting message will have a positive impact on air traveller's *attitudes* towards voluntary carbon offsets	*No*
2	The *loss-framed* voluntary carbon offsetting message will have a positive impact on an air traveller's voluntary carbon offsetting behaviour compared to the gain frame or the no frame message.	*Partially*
3a	Positive attitudes towards voluntary carbon offsetting will not be reflected in commensurate behaviour (attitude-behaviour gap)	*Yes*
3b	Positive attitudes towards voluntary carbon offsetting will not be a pre-requisite for offsetting behaviour	*Yes*
4	Positive intentions for voluntary carbon offsetting will not be reflected in commensurate behaviour (intention-behaviour gap)	*Yes*

Source: author's own

Measuring and evaluating attitudes towards voluntary carbon offsetting is important for understanding how these are perceived among the general population, and to log how this differs geographically and through time. In addition to being valuable in itself, this knowledge represents a necessary component in the behavioural change toolbox: by understanding what people think of voluntary carbon offsetting we are better equipped to design interventions that aim to improve these sentiments. Improving attitudes is also essential to increase public support for ambitious environmental policies.

In the study presented here, attitudes towards voluntary carbon offsetting can be external to the model – that is, formed beforehand – or an outcome of the intervention. With the RCT approach to study design – concretely, the control group component – I was able to delineate these two effects.

The analyses of treatment effects on attitude show that neither loss nor gain framing impacted the participants' attitudes towards voluntary carbon offsetting. This is in contrast to findings from the literature, which point to a statistically different effect of loss and gain framing on preferences, including attitudes towards behaviour (review provided in chapter 2.2). The result also contrasts with predominant research in communication studies (e.g. Spence and Pidgeon, 2020), where positive framing is found to be more effective in the context of climate change mitigation.

The positive association between subjective norms and attitude ($\beta = 0.289$; $t = 7.35$) seems to confirm the postulate of the theory of planned behaviour (Ajzen, 1991) that individuals' decisions are influenced by the beliefs and actions of those close to them. One must interpret the results with caution, however – it may also be that expressing a positive attitude towards carbon offsetting influences one's judgment about the beliefs and behaviour of others; in other words, that the relationship is inverse. The Beliefs2 variable ($\beta = 0.289$; $t = 6.04$), which is a composite of trust in carbon offsetting organisations and belief in their project

output efficacy, may also be a victim of consistency bias. Indeed, since both the belief and attitude constructs are behaviour-specific, they may be too closely intertwined to draw meaningful conclusions.

Willingness to accept higher taxes and pay higher prices to the industry for environmental protection (variable Env-econ trade-off) is positively associated with attitude towards voluntary carbon offsets. This is consistent since voluntary carbon offsetting also represents a cost to the consumer made towards climate change mitigation. Male respondents were statistically less likely to express a positive attitude towards offsetting, which is consistent with findings from previous research (Choi and Ritchie, 2014; MacKerron et al., 2009).

5.1.3 Treatment effect on behaviour

My results indicate that the loss frame had the theory-predicted statistically significant effect only when the framed message immediately preceded the behaviour; the effect disappeared once questions on attitude towards voluntary carbon offsetting were moved between the framed description and the offsetting decision.

One explanation for the ambiguity of the results in contrast to those of other framing studies – 90% of which found either loss or gain framed messages to effectively induce pro-environmental behaviour (Homar and Cvelbar, 2021) – lies in the pecuniary nature of the cost of behaviour. Indeed, in none of the studies reviewed did the participants suffer a financial loss from engaging in the behaviour. By contrast, the study reported on here asked the participants to make an economic decision that was associated with a loss in earnings, similar to how they would in the real world. Quite discouragingly, these results suggest that green nudging may not be as effective in encouraging green behaviour if it carries a financial sacrifice, rather than effort, time or other inconvenience.

Nevertheless, for the behaviour-then-attitude survey order, a loss framed environmental message did have a statistically significant effect at the 5% level. To explore why this may be the case, we may turn to dual process theories of the mind. The importance of survey order for the significance of loss framing suggests that the framing effect may have taken place as a 'System 1' nudge, influencing a decision-making process that is automatic, subconscious and effortless (Wason and Evans, 1974). By contrast, by forcing the subject to reflect on their opinion of voluntary carbon offsets, questions on attitudes and beliefs may have transformed the decision on purchasing an offset from a 'System 1' to a 'System 2' (that is, a deliberative and conscious) process, thereby diminishing the effect of loss framing. Having prompted a conscious appraisal of voluntary carbon offsets, the questions diminished the subconscious effect of loss aversion on the behaviour. Supporting this interpretation is the fact that in the control group (without the framing nudge), it was the attitude-then-behaviour survey order, which demanded more deliberate reasoning, that was associated with a higher likelihood of offsetting. A similar interpretation sees the reason for the different effects of the two survey orders to lie in the short-lived nature of the framing nudge, not in the different systems of processing. Namely, a loss frame may have increased the likelihood of (consciously) deciding to offset where this decision took place immediately after the frame. In the attitude-then-

behaviour survey order, participants may have, by contrast, forgotten about the frame, causing it to lose its effect.

Whilst the literature on pro-environmental behaviour examined a number of interactions with loss and gain framing – including construal level (Grazzini et al., 2018) and emotions (Amatulli et al., 2019) – the effects of survey order to my knowledge remained unexamined. Its interaction with the treatment is worthy of examination where two or more potentially interdependent response variables are included in the same questionnaire. Not randomising survey order in these instances can be attributed to the tendency of researchers to give precedence to analytical methods for proving the non-existence of common method bias.

There are, however, some relevant examinations into response times. In a framed field experiment on EU-ETS offset allowances, Lohse et al. (2016) find that it was slower, and therefore more deliberate, decisions that were associated with purchasing an offset allowance; fast (automatic and intuitive) decisions were more likely to be done by participants that chose not to contribute. My own post-hoc analysis on response time effects did not yield statistically significant results. However, firm conclusions from this cannot be drawn; since response time data is prone to noise, much larger sample sizes are recommended for studies examining response times (Rubinstein, 2007). Notwithstanding, survey order analysis did point to a positive relationship between speed of decision-making (as proxy of cognitive system activated) and the likelihood of making the pro-environmental choice. One reason for the discrepancy between my own data and theirs is that I specifically examine the effect of an intervention. Indeed, as shown in Figure 23, in the control group, deliberate reasoning was associated with a *higher* likelihood of purchasing a carbon offset (column 1 compared to column 2). By contrast, reading either a gain- or loss-framed description of voluntary carbon offsetting turned this relationship around: choosing to offset was more likely when the participants were not asked to reflect upon their opinion of this climate change mitigation effort.

Finally, the attitude-then-behaviour survey order regression results lend themselves to another interpretation. Namely, both valence framings were associated with a negative effect on behaviour compared to the control group – though only the gain frame effect was statistically significant in the univariate analysis, and neither effect was significant in the multivariate analysis. Nevertheless, it could be that the subjects in the two treatment groups felt manipulated by the frames, leading to a negative psychological reactance effect on offsetting behaviour. Indeed, it may be that participants were more likely to feel manipulated by the loss and gain frames (than by a neutral description) in both survey orders, but that when the frame immediately preceded the offsetting decision, it nevertheless had a positive effect on behaviour.

The most common reasons for offsetting provided by the participants themselves were that it is “the right thing to do” (74%) or makes them “feel good” (64%). It is important to note, however, that the elicited reasons constitute ex-post reasoning; whilst they may be qualitatively interesting, for behavioural economists they do not necessarily reflect the actual

reasons at the time the decision was made. As Haidt (2001) explains, reasons based on preferences, values, beliefs or social norms are presented by using System 2 *after* the decision has been made intuitively using System 1.

5.1.4 Discussion of other factors that influence carbon offsetting

Since the study consisted of a real-behaviour experiment and questionnaire component, it was able to match one's habits, psychographic- and socio-demographic characteristics to both attitudes towards voluntary carbon offsetting and individual offsetting behaviour. Elsewhere, these characteristics (or a subset thereof) were tested for their effects on stated preferences (see chapter 2.4). It is therefore worth investigating which of these many variables were associated with higher likelihood of offsetting.

Three of the 24 control variables in the model had a statistically significant effect on the offsetting decision: biospheric value orientation, one's past donation to environmental causes, and one's position on the environment-economy trade-off. The latter was also associated with more favourable attitudes towards voluntary carbon offsetting and is consistent with Xiao and Dunlap's (2007) Model for environmental concern. Recall that high scores on the trade-off reflect a preference for the environment at the expense of economy (namely, tax and consumption costs), whilst low scores suggest the individual cares more strongly about money compared to the environment. Voluntary carbon offsetting represents a cost to the consumer in order to protect the environment – both in reality and within the experiment – which explains the statistically significant effect of this variable on behaviour. The relationship between biospheric value orientation and pro-environmental behaviour provides support for Stern et al.'s (2000) value-belief-norm theory. In other words, for many individuals, behaviour was consistent with a worldview, in which concerns for the natural world dominate. In contrast to the previous two variables, past donation to environmental causes is negatively correlated with propensity to offset. This may seem inconsistent if both past and current donation reflect underlying preferences towards giving money for environmental benefit. It also contrasts with findings from Schwirplies et al. (2019) who observe a positive relationship between past donations to charity (in general) and propensity to offset. On the other hand, past donations could, in the minds of the individuals, justify not giving the task earnings here, representing a moral licensing effect. It must be noted that past purchases of voluntary carbon offsets specifically served as a separate variable – one which was not statistically significantly associated with behaviour in the experiment.

Behaviour-specific beliefs and subjective norms, which were positively correlated with attitudes towards voluntary carbon offsetting, had no statistically significant effect on behaviour, and neither did self-efficacy. This represents a divergence from the theory of planned behaviour, according to which behaviour is (through intention) driven by subjective norms and perceived behaviour control (Ajzen, 1991). Involvement in an environmental movement and green lifestyle had no statistically significant effects on the offsetting decision. Rather than portraying meaningful behavioural inconsistency, this result lends to the interpretation that individuals are not simply 'green' or 'not green' but their actions and

decisions display nuances. Together with the absence of significance of past purchases of voluntary carbon offsets, it does, however, caution against inferring future behaviour from similar past reported behaviour.

Controls for frequency of flying, familiarity with voluntary carbon offsetting, and Covid-19 pandemic impacts on travel did not have a statistically significant effect on the offsetting decision. Finally, behaviour did not differ significantly across socio-demographic characteristics of gender, age, income, education, employment, political orientation and family size. Blasch and Farsi (2014) reach similar results, finding that socio-demographic variables (gender, number of children, level of education, income) do not have a statistically significant effect on offsetting, though in their study age does. Age is similarly found to be negatively associated with the likelihood of offsetting in Loschel et al. (2013), who, similarly to my study, also do not find gender, education level, employment or income to have an effect. The few other real behaviour studies (Arana and Leon, 2012; Arana et al., 2012) consists of field experiments that were unable to capture details on the participants.

5.1.5 Relationship between attitude and behaviour

This study provided further support for the attitude-behaviour gap reported for pro-environmental behaviour in travel and tourism (Juvan and Dolnicar, 2014) and more generally (e.g. Kollmuss and Agyeman, 2002). In support of hypothesis 3a, less than half of the participants that expressed a positive attitude towards voluntary carbon offsetting went on to purchase an offset within the experiment. One reason for this could be that these subjects had already purchased an offset in the past, though this explains at most 16% of the gap.

A number of justifications for the attitude-behaviour and intention-behaviour gaps proposed in the environmental psychology literature (see section 2.1.9 in the second chapter of the thesis) are not tenable here. In terms of measurement (Sheeran, 2002), both the attitude and behaviour questions pertained to voluntary carbon offsetting specifically (rather than climate change, for instance). There were no infrastructural or institutional barriers to carrying out the behaviour (Kollmuss and Agyeman, 2002), and internal factors such as norms and beliefs (Stern et al., 1999) were controlled for. It can also be argued that individuals who expressed a positive attitude but did not offset simply liked the idea but did not consider it for themselves. This does not in itself necessarily represent cognitive dissonance in the mind of the decision-maker. People can have a positive attitude towards a behaviour, outcome, item or concept but not consider engaging in/with it themselves, and this may be for a number of conscious and rational reasons, not least because it simply is “not for me”. Insofar as expressing a positive attitude towards offsetting improves utility through positive self-image, indicating a positive attitude but not engaging in behaviour (nor having the intention to do so) may be the rational decision. In other words, an attitude-behaviour gap is not a ‘theoretical anomaly’. It does, however, suggest proceeding with caution when inferring plausible behaviour from expressed attitudes.

The results also showed that 28% of participants with an overwhelmingly negative attitude towards voluntary carbon offsetting chose to offset nonetheless. This implies favourable

attitude is not a prerequisite for behaviour. The finding has important theoretical and practical implications. One explanation for this can be drawn from studies on affect. The loss frame could induce feelings of guilt or shame among the participants (e.g. Amatulli et al., 2019), leading to a higher propensity to offset without a change in attitudes. Asked about their (subjective) reasons for choosing to offset, however, participants with a negative attitude cited emotional consequences of not doing so only a third of the time (27% guilt and 5% shame).

It can alternatively be contested that it is (the less rational) cognitive biases that caused the gap between attitudes and behaviour. A dual-process theory argument would be that attitudes stem from System 2, whereas behaviour may be more impulsive and represent System 1 decision-making. Cognitive biases may also be connected to System 2 reasoning. An example relevant here is mental accounting, defined as "the set of cognitive operations used by individuals […] to code, categorise and evaluate financial activities" (Thaler, 1999, p. 183). In this case, the participant may consider 'income from experiment participation' as a separate compartment from 'cost of vacation', leading him to decide to not offset here.

Transferring this finding into practice, it appears to confirm assumptions implicit in nudge theory that choice architecture can be used to induce desirable behaviour *without changing attitudes*. That so many participants chose to offset despite expressing a negative attitude towards doing so also contradicts with the consumer preference perspective rooted in the theory of planned behaviour. This is verbalised in, for instance, Zhang et al. (2019b, p. 718) who take as given that "positive attitudes and purchase intentions are prerequisites for purchasing environmental goods and services".

Another interesting observation is the difference in the extent of the attitude-behaviour gap across treatments and between the two survey orders. As Figure 23 shows, the loss frame was associated with a disproportionately high propensity to express positive attitude but not offset thereafter (column 5) and higher likelihood of first offsetting and then indicating a positive attitude (column 6). This lends support to the interpretation that the loss frame as a nudge influences automatic cognitive processing and is thus effective only when it immediately precedes the decision (on the attitude as in column 5 or on the behaviour as in column 6).

5.1.6 Relationship between intention and behaviour

The results showed that of the 391 participants who expressed an intention to purchase an offset, 179 (46%) carried through with this decision within the study. More than half (54%) of the respondents who indicated an intent to allocate the proceeds from the task to a voluntary carbon offsetting organisation changed their minds once given the opportunity to collect their earnings instead. These results join the findings of Klein and Hilbig (2019), Seip and Strand (1992), Huber et al. (2018) and Bouma and Koetse (2019), where pro-environmental behaviour was also found to be considerably lower than the intention to carry it out.

It is conceivable that, having conducted online research experiments in the past, the participants were familiar with these setups and guessed that they would be given the opportunity to take home their earnings; for these individuals, the intention was never there. I believe this cannot explain the large share of individuals whose offsetting decision did not reflect intention. As with attitude, differences in measurement do not apply here, since both variables pertained to voluntary carbon offsetting in particular, rather than climate change mitigation or environmentally-friendly behaviour more generally. That said, the decision for intention in this study was not semantically identical to the decision on behaviour. Namely, it could not capture individuals who would have purchased a voluntary carbon offset within the study but would have preferred to do so with their own money (or those earned from participating in the study itself) rather than engage in a task, which they may consider time-consuming or tedious. Notwithstanding, these individuals would not have changed the intention-behaviour gap, as measured in terms of number of people deviating from their expressed offsetting intention. Another conscious reason – one which was not captured in the questionnaire – could be an absence of trust in the experimenter, though this was sought to be mitigated through providing my contact details in case the participant wanted to follow up.

Barriers to behaviour explored in the literature, such as absence of infrastructure to carry out an action (Kollmuss and Agyeman, 2002), scarce financial resources, lack of knowledge or ability for execution, and absence of opportunity (Sheeran, 2002), can also be excluded in this setting.

A further explanation for the discrepancy is offered by the low-cost hypothesis of environmental behaviour, which predicts a negative relationship between behavioural cost and the size of the effect environmental concern has on that behaviour (Diekmann and Preisendorfer, 2003). An individual will carry out an action that is consistent with their level of environmental concern only when the cost of doing so is low – in these cases, the utility experienced from this consistency (i.e. reduction of cognitive dissonance) exceeds the utility from not paying the cost of the behaviour. Since the pro-environmental behaviour in this study was associated with a cost, any environmental concern may have been less likely to lead to behaviour. This is in contrast to other real behaviour studies examining framing effects on the environment, where behaviour demands effort or even brings financial benefits (Homar and Cvelbar, 2021). Rather discouragingly yet unsurprisingly, the finding suggests that when decisions carry financial costs, people are less willing to act on their intentions.

Another explanation that may indeed have affected the gap is the temporal split between the decision on intention and that on behaviour. Though negligible when compared to real life scenarios, the temporal break in the form of the real effort task may have nevertheless led to participants forgetting that indicating they will do the task meant allocating money towards voluntary carbon offsets. This does imply that either intention or behaviour or both were not a reflection of preferences or that these were not consistent. In other words, the two decisions may have not (both) been rooted in rational choice. Perhaps intention to offset reflected environmental concern but behaviour was a result of impulse System 1 decision-making.

Alternatively, indicated intention could have been the result of automatic cognitive processes, and the behaviour a reflection of true preferences.

The findings on the gap between intention and behaviour, exhibited in this study, lead to the interpretation that intention is a hypothetical measure. Rather than serving as a methodologically useful proxy for behaviour, intention may have to be treated as its own psychological phenomenon, not necessarily indicative of future behaviour.

5.2 Contribution to the body of knowledge

5.2.1 Loss framing in the environmental domain

With these results, the study joins existing research on framing effects on pro-environmental behaviour, which overwhelmingly find that loss framing is more effective in inducing desired behavioural change (Homar and Cvelbar, 2021; see also chapter 2.2 of this thesis). This is one of the few studies – to be precise, seven conducted before the end of 2019 – to test real behaviour. Measuring changes in attitudes is appropriate when the goal of an intervention is to change attitudes; the same holds for behavioural intentions, willingness to pay and other forms of stated preferences. Similarly, when the aim of an intervention is to change regular behaviour or a single action, we ought to measure behavioural responses to that intervention. Understanding the specific outcome variable of interest – rather than making assumptions of one based on findings from another – is especially important given the discrepancy between attitudes, intentions and behaviour.

The study presented in this thesis is also the only one to test framing effects for carbon offsetting behaviour in particular. This is valuable because predictors of pro-environmental behaviour, and by extension the interventions aimed at changing it, may be specific to each type of behaviour (Steg and Vlek, 2009).

Finally, to the extent of my knowledge, this is the only study on loss framing where behaviour carries a financial cost to the participants. This brings it closer to a number of real world decisions on behaviour, which also represent a cost to the individual – in addition to voluntary carbon offsetting, also the purchase of more environmentally friendly goods (often more expensive than the alternative) or donation to environmental charities. That loss framing was relatively successful despite the cost of the pro-environmental behaviour represents a promising finding for practical applications of the nudge into decisions with a price tag (see section 5.3). One may also argue that this pecuniary nature of the good means the intervention is exclusively a pro-social nudge, rather than a pro-self nudge. Alternatively, a long-term view on individual self-interest may see pro-environmental behaviour as beneficial to the individual, suggesting the pro-self nature of the nudge remains.

5.2.2 Loss aversion for non-monetary and public goods

The evidence on loss message framing effects on pro-environmental behaviour collected in the systematic literature review and partially found in this thesis' own experimental study

suggests individuals may be loss averse when it comes to environmental outcomes. That is, with their action, they avoid negative environmental change more than they seek commensurate positive environmental change.

This is an intriguing finding because the environment is largely a public and non-monetary good, which distinguishes it from the monetary and private goods loss aversion was originally observed for (and, indeed, developed as one of the building blocks of prospect theory). As shown elsewhere (e.g. Wilson et al., 2008), an individual's perception of benefits and losses to others is not equivalent to the benefits or losses as he or she experiences them. Even when environmental impacts can include consequences for the individual, this linkage is less palpable than in areas where the impacts are private (such as personal health or savings), requiring conscious thought processing to register, connect and act upon. The fact that this is essentially a non-monetary good may further obfuscate the individual's ability to contextualise and evaluate a particular outcome.

The non-monetary nature of most environmental outcomes also opens up some interesting dilemmas regarding loss aversion and environmental decisions: what is the loss individuals may seek to avoid? What is the reference value, with respect to which we measure loss? Is it the current state of the environment or some expected future state, which may already be a deterioration of today? Further, what are the mechanisms through which loss aversion here induces pro-environmental behaviour? Looking deeper, one may find that the individual imagines the tangible loss to the environment his action leads to, or, alternatively, that the framed message only represents a linguistic device that leverages negativity bias in attention without real-world implications.

Does loss aversion work through negative emotions, such as fear, sadness, shame or guilt? A number of studies do indeed test this by asking their experimental subjects explicitly (Amatulli et al., 2019; Nilsson et al., 2014) or by observing behavioural intentions after inducing these emotions (Baek and Yoon, 2017). In my own study, participants were asked to provide reasons for choosing to offset; less than a third indicated guilt or shame. Yet here, too, one must avoid making conclusions on underlying behavioural mechanisms based on the answers provided by the experiment participants; instead, the research question demands a more neuroscientific examination. Since a number of these emotions are relatively well understood in terms of cerebral activity, emotional drivers of loss aversion are a promising research topic (Camerer et al., 2005). A final question, as Camerer et al. (2005, p. 131) provocatively ask, is whether loss aversion is a judgment error or "a genuine expression of preference".

The discussed loss aversion can be observed and measured through one of the three cognitive biases that stem from it: loss framing, endowment effect and default effect. This thesis has focused on the former. Examining a potential endowment effect can be done for an environmental good – for instance, by measuring discrepancy between willingness to accept and willingness to pay – but not for some specific behaviour. Meanwhile, while leveraging the default bias showed great promise elsewhere (Pichert and Katsikopoulos, 2008) and for

carbon offsetting behaviour more specifically (Arana and Leon, 2012), there exist legal restrictions to its use in this setting: changing the default option goes against European Union consumer protection regulation (Directive 2011/83/EU, Article 22), which reduces the practical applicability of this nudge.

5.2.3 Cognitive aspects of decision-making

Though survey order was initially randomised with a view to minimise common method bias, it showed to have an important effect on the outcome variable. Namely, the loss framed message had a statistically significant positive effect on behaviour only in the survey order, in which the real effort task and behaviour question immediately followed the message. To understand why this is we can turn to one of the principal theoretical theories underlying this thesis: dual process theory. One interpretation is that in this survey order, the offsetting decision may have been made subconsciously; though there was a temporal break between the nudge and the decision in the form of a real effort task, the task was unrelated to the topic and required enough effort to prevent the participant from reflecting on the message they just read. Moreover, the framed message was repeated on the offsetting decision page, and so the effect may have taken place there. By triggering a conscious reflection on one's opinion of carbon offsets, questions on attitudes ensured the decision on offsetting was made from System 2, i.e. consciously and deliberately. For this cognitive 'system', loss framing did not seem to have an impact. As mentioned in section 5.1.2, this interpretation of the survey order effect is further supported by results of the control group, in which the likelihood of offsetting was higher in the opposite survey order: without a nudge, a reflection on one's attitudes towards voluntary carbon offsetting was associated with higher propensity to offset.

This is the first study, to my knowledge, to make a connection between survey order and cognitive processes underlying the decisions. An alternative approach would be to use response time data (see section 5.1.2), but here these did not show to have an effect.

The important question here is whether the decision-making process matters importantly and systematically for individual decisions about pro-environmental behaviour. This has both theoretical and practical ramifications. For theory, it would contribute to the scholarly discussion in economics (and environmental economics, in particular) on the relationship between stated preferences and behaviour (Lohse et al., 2016). More generally, investigating cognitive foundations of decision making matters for understanding whether it is intuition (a characteristic of System 1) or deliberation (System 2) that is associated with more cooperative choices (ibid.). In practice, this finding would suggest the effectiveness of an intervention will depend on whether it invokes a strong emotional response or otherwise triggers a quick intuitive response, or whether it favours reflection.

5.2.4 Gap between stated preferences and behaviour

The study on the effects of loss framing on voluntary carbon offsetting decisions reported on here found important differences between attitudes towards voluntary carbon offsetting and offsetting behaviour, with only 58% of decisions on offsetting corresponding to the

participants' attitudes. Of those, 28% (56 participants) voiced a more negative attitude towards offsetting yet chose to offset nonetheless. The results also pointed to a significant gap between intentions and behaviour – 54% of the participants who indicated an intention to purchase an offset did not carry out the corresponding intended behaviour. The interpretation of these results is provided in sections 5.1.4 and 5.1.5.

With these findings, the study contributes to the discussion on the contrast between stated preferences and behaviour among behavioural environmental economists, environmental psychologist and environmental economists. Owing to the study's context of examination, the results and insights collected here may be especially valuable to tourism scholars and, in particular, researchers in voluntary carbon offsetting.

The first contribution of this thesis is the very measurement of the gap between attitudes and behaviour, and between intentions and behaviour. The discipline of behavioural economics has only recently seen a rise in interest in environmentally-relevant individual decision-making. Potential misalignment between self-reported preferences and actual behaviour can be interpreted not as an anomaly but a representation of bounded rationality inherent to behavioural economic thought. Thaler and Sunstein (2009), for instance, explain that it is not just economic incentives and preferences that matter for behaviour, but also the choice architecture. As far as I was able to find, where researchers do concern themselves with the gap between stated preferences and pro-environmental behaviour, it is to quantify the gap between willingness to pay and willingness to accept for an environmental good. This is called hypothetical bias (Harrison and Rutstrom, 2008) and has been found to be strong for environmental goods, though evidence is rather dated (Cummings, 1986).

Although there is widespread awareness of the attitude-behaviour gap in the environmental psychology literature (both general and tourism-specific), this is mostly used as a stepping stone for qualitative exploration (Hibbert et al., 2013; Juvan and Dolnicar, 2014) or as motivation for measuring real behaviour (Berger and Wyss, 2021; Dolnicar et al., 2017), but rarely measured explicitly. Gaps between behavioural intentions and behaviour are dedicated even less research, with some papers going as far as suggesting the observed behavioural intentions can be used to represent behaviour (e.g. Denton et al., 2020). The experimental study presented in this thesis provides a measurement of the discrepancy between behaviour-specific attitudes and the behaviour. It also shows that positive attitudes are not a pre-requisite for behaviour, a finding that runs counter to the linear attitude-intention-behaviour progression postulated in the (most frequently cited) theory of planned behaviour (Ajzen, 1991).

The second contribution of this thesis is the theoretical reasoning behind the observed gaps between attitudes and intentions on the one hand, and behaviour on the other. I have brought in and appraised a wide range of explanations (see sections 5.1.4 and 5.1.5). For this, I borrowed from utility theory in economics (positive attitudes improve self-image, which improves utility without the need to change behaviour); theory of planned behaviour (measurement discrepancies) and other justifications offered in environmental psychology

literature (external barriers to behaviour); as well as from behavioural economics' dual process theory, according to which reported preferences are gathered in System 2 but behaviour follows from System 1 decision-making.

5.2.5 Nudging in tourism and voluntary carbon offsetting

To tourism and travel research, the study reported on here contributes new tools and methods for encouraging pro-environmental behaviour among tourists, which are theoretically drawn from behavioural economics and methodologically from experimental economics. Using behavioural insights to test and improve pro-environmental behaviour in tourism has been a relatively recent trend. Most studies examine the effect of a specific green nudge, such as default rules (Knezevic Cvelbar et al., 2021) or social norms (Goldstein et al., 2008). Loss and gain framing has been explored in the hospitality context: Blose et al. (2015) and Hu et al. (2018) analyse the effects of valence framing on hotel guests' intentions to reuse bed linen, whilst Grazzini et al. (2018) explore the effects of framing on guests' recycling rates. All three studies found loss framing to have a greater effect than gain framing, particularly when combined with a moderator (proximity of benefits, message source and construal level, respectively). Though the studies have the advantage of also exploring moderation effects, their weaknesses vis-à-vis my own experiment is the absence of a control group, against which both frames can be reliably compared. Second, none of the studies other than Grazzini et al's (2018) field experiment measure real behaviour and none look at travel behaviour. Finally, my study aims to go deeper: I start from theory and test whether it holds also for behaviour that differs substantially and systematically from the one envisaged by this theory. More concretely, I test whether the loss aversion component of prospect theory can be extended from financial decisions under risk to pro-environmental behaviour.

Within tourism and travel literature, voluntary carbon offsetting constitutes a sizeable independent research topic. Yet, as presented in chapter 2.4, most of the published work investigates stated preferences (particularly, willingness to pay) and how they change in response to changes in the description or presentation of the projects funded through offsetting. I complement this research by testing a nudge – a change to the environmental appeal – that is theoretically predicted to work at the subconscious level, and to do so on both real behaviour and stated preferences. To avoid redundant repetition, I would here refer the reader to other sections of chapters 5.2, 5.3 and 5.4 – the contributions presented by my study present value and relative novelty for tourism and travel research even more so than to wider economic psychology and behavioural economic literature.

5.3 Practical implications and recommendations

5.3.1 Loss framing as a green nudge

This study found loss framing to have a statistically significant effect on pro-environmental behaviour as long as attitude is not (yet) asked after. To public and private stakeholders in tourism, the findings on loss framing effects suggest introducing or manipulating an existing description so it presents the negative outcomes of not carrying out a pro-environmental

action. They would also be advised to place the framed description temporarily and/or physically next to the desired behaviour, rather than as part of an information campaign. For instance, travel agents may decide to rephrase descriptions of voluntary carbon offsets that accompany the option to purchase them directly at the point of reservation of air travel or other public transport tickets online. The non-governmental organisations that sell them could do the same.

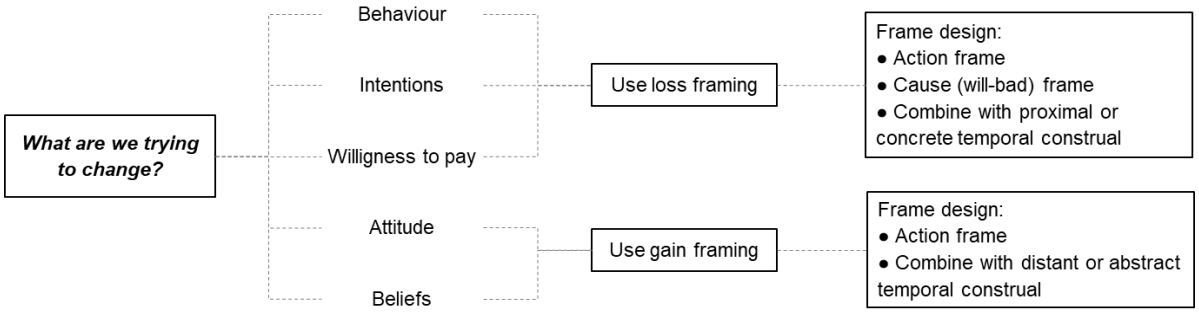
Elsewhere in the domain of pro-environmental behaviour, this may mean placing loss-framed environmental appeals on recycling bins to encourage recycling, in hotel bathrooms to encourage reductions in water use or next to air conditioner displays to encourage more frugal energy use. Loss framing may by contrast be less effective for changing behaviour when used in education or information campaigns.

It is important to note that there are two types of decisions on behaviour that may be subject to nudges: one-shot behaviours and regular behaviours (Stankuniene et al., 2020). The former include investments into renewable energy appliances, choices on travel destination, accommodation and transport, as well as the corresponding decision on purchasing a voluntary carbon offset for the chosen transport mode. For regular behaviour, this involves reductions of negative environmental impact of everyday behaviour, such as transport choice for commuting to work, recycling and composting, lower energy and water use, and so on[15]. The results of this thesis' study provide partial evidence for the effectiveness for one-off behaviours, but say nothing of the latter. The real behaviour experimental studies captured in the systematic literature review, by contrast, do observe regular, frequent behaviour (e.g. energy usage in Gonzales et al., 1988; curbside recycling in Lord, 1994, and White et al., 2011). It follows that there is preliminary evidence that loss framing may work for both types of decisions.

The results of my study notwithstanding, findings from the systematic literature review reveal that if policy makers want to change attitudes or beliefs, gain framed environmental appeals may be more effective. The literature review also showed that the priority of policy makers when using framing to encourage pro-environmental behaviour should be to craft messages in a way that portrays the potential repercussions of carrying out an alternative harmful behaviour as a loss, rather than detailing the positive consequences of the encouraged behaviour. This means framing the desired behaviour as an action, not avoidance (see Figure 25); it also means describing the negative effects of a loss frame (if chosen) and either potential positive or negative consequences of a gain frame.

[15] The individual may of course make the decision to be pro-environmental everyday anew, but the behaviour is by nature regular rather than one-off.

Figure 25: Intervention tree



Source: author's own

It is important for policy makers to recognise that loss framing is not a panacea: as it appears to lead to behavioural change subconsciously, the continuous presence of the intervention is a pre-requisite for maintaining the green behaviour. Nevertheless, the effect of the nudge may diminish over time as people become less perceptive to it (e.g. Ferraro et al., 2011). Applied in policy, nudges – framing being no exception – have also been criticised for being both inadequate in addressing complex social issues (Bhargava and Loewenstein, 2015) and too intrusive, paternalistic and elitist (White, 2013), depending on the vantage point and policy compared with.

5.3.2 Policy mix

Despite its drawbacks, loss message framing does offer a useful complement to existing policy instruments that target conscious thought processes, such as information and education campaigns, financial incentives and regulation. The promise in this lies in targeting different levels of cognitive processing simultaneously, as well as different channels of behaviour change – subconscious behaviour directly, but also through transforming attitudes and beliefs.

The drawbacks of studying stated preferences notwithstanding, improving pro-environmental attitudes may still have a positive impact by increasing citizen support for ambitious environmental policies (Farjam et al., 2019). The best approach may then be to roll out (more subconscious) nudges targeted at improving behaviour, while simultaneously launching information and education campaigns to improve public opinion at the conscious level (Shogren, 2012).

Policy makers might also consider carbon tax in combination with a framing nudge. Two variations of this may be possible: applying loss framing to the policy itself or to the way it is communicated. For the former we can lean on insights from framing experiments that appeal to monetary outcomes (Muralidharan and Sheehan, 2016; Vogdrup-Schmidt et al., 2019). As incentives for behavioural change, the prospect of an additional charge, tax or loss in income work better than discounts, saving or fee avoidance. Yet if policy makers want to implement a mandatory carbon tax in any event, rather than as 'punishment' of environmentally-damaging behaviour, they may find less support for it. A second option is to apply loss

framing to information campaign accompanying the roll-out of the new tax by describing the negative effects on the environment if the tax had not been implemented. To my knowledge, neither of the two options has been experimentally tested yet.

When considering whether to jointly implement a green nudge that leverages loss aversion, such as loss framing or changing the default option, and a carbon tax, an appropriate question is whether crowding out may occur. Namely, if green nudges – which have marginal positive effects at a very low cost (Sunstein and Reisch, 2013) – can crowd-out support for a carbon tax, which have higher potential but are also more difficult to implement.

Examining the combined effect of a carbon tax with a green energy default nudge, Hagmann et al. (2019) find that the latter reduces support for a carbon tax. They conclude that that this occurs because green nudges provide false hope that climate change can be addressed without large financial costs. Most participants in their six experiments also wrongly considered the effectiveness of carbon tax and a green nudge in reducing carbon emissions to be equal. This may be due to genuine absence of knowledge or motivated reasoning. The authors further find that the crowding out effect only occurs for policies from the same domain (e.g. a retirement savings nudge crowds out support for increasing social security contributions; a green energy nudge crowds out support for carbon tax; etc.). This opens up the possibility of eliminating crowding out if we frame the pro-environmental behaviours as distinct from each other.

Finally, Hagmann et al.'s (2019) experiments showed that informing people about the relative ineffectiveness of nudges or about positive financial spillovers from the carbon tax greatly reduces the crowding-out effect, and it does so without reducing support for the nudge. Even where the crowding out occurred due to motivated reasoning (rather than unawareness), providing information at the point of the decision makes motivated reasoning more difficult.

For voluntary carbon offsetting in particular, a stated-preference survey found that a (real) mandatory carbon tax did not reduce an individual's willingness to pay for voluntary carbon offsets (Choi et al., 2018).

5.4 Methodological contribution

The study in this thesis is characterised by the following methodological features: randomised controlled trial, online experiment (as a type of remote laboratory experiment), incentive compatibility and real-effort task.

With this, it is methodologically aligned with a number of experiments reported on in the behavioural environmental economics literature (see Lange, 2022, for a review). That said, my study does have some methodological strengths that distinguish it from other research into pro-environmental behaviour within this discipline. First, it includes a control group, to which results from the two experimental conditions are benchmarked. Somewhat surprisingly, very few studies that examine the effects of framing on pro-environmental decisions have a control group (Ahn et al., 2015, and studies 1 and 2 in Amatulli et al., 2019

being some of the exceptions). This may be because a large share of the studies in the systematic literature review (Homar and Cvelbar, 2021) also examine the effects of moderating variables, making four conditions (2x2) the minimum. Yet, including a control group or neutral condition is essential since without it, we cannot know whether either frame actually led to positive or negative behavioural (or attitudinal) change.

Second, the analysis of framing effects on voluntary carbon offsetting behaviour conducted here controls for a relatively high number of covariates, minimising omitted-variable bias. This is made possible by the composite nature of the study: in the online (rather than field) experimental setting, I was able to include a questionnaire section, which improved the regression analyses.

By applying this particular experimental method to the tourism setting of voluntary carbon offsetting for air travel, the study provides two valuable methodological contributions to tourism and travel literature: an incentive-compatible experimental design with a real effort task.

5.4.1 Incentive-compatibility

The study at the heart of this thesis presents an idea for an incentive-compatible measurement of real behaviour in an online (rather than field) setting. This is useful because online experiments allow more comprehensive data collection on the participants than field experiments, where matching behaviour to individual characteristics (socio-demographics, habits, values, etc.) is difficult. Incentive compatibility in a choice task holds when it is better for the participants themselves to behave in line with their true preferences (Smith, 1991). Incentive-compatibility in experimental design is now used almost ubiquitously in behavioural and experimental economics (Buckell et al., 2020), though the reader must be aware that incentive compatibility is not restricted to the measurement of real behaviour.

The incentive-compatible component of the study on message framing presented here is the financial decision on whether or not to allocate the (maximum) £1 earned from the task to a voluntary carbon offsetting organisation: it is in the participant's interest to be truthful since the consequence of the decision is real rather than hypothetical.

They key for pro-environmental behaviour is not just the incentive, but *compatibility.* Where the real cost is monetary, an incentive-compatible experimental design includes a monetary cost; where behaviour in real life is not monetary, an online experiment with financial costs will not be able to be incentive-compatible. An incentive-compatible experimental design is thus only appropriate where the real world equivalent also carries a monetary cost, such as the purchase of voluntary carbon offsets, but also higher environmental taxes, higher prices for eco-friendly goods or organic produce, and donation to an environmental charity. This experimental feature would by contrast not be suitable for examining behaviour that requires (offline) effort or time, such as recycling, taking the bicycle or public transport to work, or even breaking of inertia which brings financial benefits (energy efficiency, water efficiency).

5.4.2 Real effort task

The second good practice from experimental economics this study brings to tourism studies is the use of a real effort task. To the extent of my knowledge, real effort tasks have not yet been used in tourism research. They represent a useful method for generating income within the experiment that the participant can then allocate as he or she would in the real world. Real effort tasks thus reduce house money effects associated with merely giving the participant some money to spend as he or she wishes, and thereby mimic real world economic sacrifices (see chapter 3.4.1).

5.5 Limitations

5.5.1 Theoretical limitations

Theoretical limitations pertain to the focused topic and context. Though focus is necessary for conducting in-depth analysis, it does mean that a number of interesting and valuable topics were not investigated. In terms of the main topic of loss aversion, I only examine one of its manifestations – loss framing – but not default bias or endowment effects. This is partly due to the pro-environmental behaviour of choice: effect of a default option has already been experimentally tested a number of times (Arana and Leon, 2012; Arana et al., 2012) and, at the same time, is practically unfeasible in the EU due to consumer protection regulation. Loss framing, by contrast, has not yet been experimentally tested for voluntary carbon offsetting behaviour. An endowment effect, meanwhile, can be observed for an environmental good rather than the action itself. The focus on loss framing was also motivated by clearer motivations when compared to default bias: the latter has been attributed to a number of reasons in addition to loss aversion, ranging from optimisation of effort and limited cognitive capacity to make a choice (Kahneman et al., 1990), to implied endorsement by the person or entity who chose which option is the default, i.e. the choice architect (Sunstein and Reisch, 2013). Examining all possible manifestations of loss aversion – though beyond the scope of a single thesis – would have brought a more comprehensive picture of loss aversion effects on pro-environmental decisions.

The thesis does not take into account the reference point, which is a core component of prospect theory. My experiment follows the studies on loss framing effects on pro-environmental decisions reviewed in chapter 2.2 in assuming the reference point is the current state of the environment. An individual's reference state when making environmental decisions could, by contrast, be their expectations of the future state. An alternative approach would then be to either explicitly ask study participants how they view environmental loss or gain, or to trigger a particular state within the study design. The importance of the reference point lies primarily in its interaction with risk aversion: individuals are predicted to be risk-averse in the gain domain and risk-seeking in the loss domain (Kahneman and Tversky, 1979), with the reference point establishing the border between the two domains.

In terms of the context, I sought to capture all types of (individual) pro-environmental behaviour in my systematic literature review, but – due to constraints of the experimental methodology – focused on one specific type for the experiment. Though the studies measuring behaviour overwhelmingly support the loss framing hypothesis, their low number (7) does call for caution when applying the interventions in practice. The diversity of the 61 studies reviewed, particularly in terms of the type of pro-environmental behaviour in focus, also means that each sub-sample is rather small, allowing the formation of generalised but not domain-specific conclusions. The same holds for the experiment on voluntary carbon offsetting conducted here.

Whilst the literature review on the effect of framing on pro-environmental decisions brought to light what I think are interesting findings about loss aversion with both monetary and environmental implications, I do not make any claims as to which one is more effective. Here I would refer the reader to the vast body of literature in behavioural economics and environmental psychology on salience in environmental appeals (Lindenberg and Steg, 2007; Van der Linden, 2015), crowding-out and crowding-in effects (Gneezy et al., 2011; Shogren, 2012) and incentive success factors (Ariely et al., 2009; Chetty et al., 2009).

Individual pro-environmental behaviour is not the only component of sustainable tourism. For a holistic perspective, one would have to bring both the theory and the study's findings together with their relevance for economic and socio-cultural sustainability. This integration is especially important due to the interconnected nature of the three pillars of sustainability, for instance the impact of climate change – primarily a concern for environmental sustainability – on incoming tourism destination's citizens, society, cultural heritage and the economy. Similarly, action taken towards mitigating climate change can have positive impacts on the local economy and society. For instance, turning to this study's contextual focus, since voluntary carbon offsetting can bring a range of co-benefits for the local population (e.g. new job opportunities and improved health – see chapter 2.4.3), nudging their purchase has the potential to positively affect all three pillars of sustainability. In this case, the positive sustainability effect does not take place *on* a tourism *destination*, but *of* a tourism *activity*.

Since the dissertation's target population were individual decision-makers facing consumption decisions – in the empirical study, individual tourists, travelling by air (i.e. 'consuming' air travel) for leisure – other stakeholders' role in environmental sustainability was not treated. The focus on individual leisure air travellers also meant I did not capture business travel and carbon offsetting done by private and public sector institutions and firms. This is particularly interesting when looking at higher university institutions which have been criticised for preaching environmental sustainability but seldom practicing it (Higham and Font, 2020). Though some universities have started to offset their carbon (e.g. Yale University – Yale Sustainability, n.d.) and others have pledged to do so (University of Glasgow, n.d.), realised commitments seem low compared to the damage done to the environment.

Finally, a limitation of any scientific work, including mine, is publication bias. Defined as the tendency of journals to prefer to publish studies with statistically significant results over studies with null findings, it is prevalent also in the social sciences (Franco et al., 2014). For my literature reviews and experimental study, this means that all research that I alluded to, and similarities or discrepancies from it, may not have represented actual empirical work conducted on this topic, just the work that has been published, leading to unintentional erroneous interpretations.

5.5.2 Methodological limitations

This study managed to overcome some of the shortcomings of laboratory experiments, but not all of them. In particular, the subjects knew they were being observed and the setting was artificial. This has a number of external validity consequences, an indicator of which is also the relatively high offsetting rate in the experiment overall – 38.5% compared to 1-10% in the real world. First, though not out of the range of offsetting costs available in the real world, £1 for a flight offset is rather low. A higher cost would be more representative of real flight offsetting costs and would better show genuine willingness to pay for it. Second, the 'choice architect' in the experiment is the researcher, whereas in the real world it is either airlines or offsetting organisations. Since academic researchers are generally perceived as more trustworthy than private companies (e.g. Besley et al., 2017), willingness to offset could have been higher than it would have in the real world. The message reaction may also be sensitive to the precise wording of the message; i.e. not just whether it emphasises the losses or gains from an action (or lack thereof), but also how strong it is. For instance, if first person plural or second person singular is used. Finally, since only native English speakers qualified for the study (in order to ensure the message is well understood), potential variations in the reaction to the loss framing nudge across cultures and nationalities was not captured, reducing global generalizability.

Due to the constraints of the Prolific platform, the intention variable (agreement to do a task in order to purchase a voluntary carbon offset) could not capture participants who did not want to do the task but did want to (and would have) purchased an offset, for instance with their own money or with the money they earned from participating in the study. As mentioned in section 5.1.6, this omission does not increase the (absolute) intention-behaviour gap, but it does potentially reduce the number of participants who purchased an offset within the study. Another limitation of Prolific may be selection bias (Greenacre, 2016), whereby Prolific participants may be categorically different to the general population and/or less reliable for seeking to earn money this way.

A further methodological limitation is the binary nature of the main outcome variable in the experiment: I was interested in whether or not the participants make a pro-environmental behavioural decision (yes/no), rather than how much they would and will pay. I also had a relatively high number of covariates that can affect purchase but only one manipulated variable (the framing treatment). A different choice of method would see more variations – project attributes, communication options, etc. – which I could insert into the utility function.

However, whilst this would be important for calculating the variables that reflect stated preference (including willingness to pay), I have made a conscious decision in my study to measure real behaviour instead. Employing different manipulations would make measuring real behaviour almost impossible, since manipulating so many variables would require a number of decisions (not only one) by the subject in order to discern individual main effects. Not only would this be very costly for us experimenters, but, more problematically, decisions would not be made independently as the subject progresses through the experiment and his earnings accumulate.

5.5.3 Practical limitations

This thesis also has a number of limitations pertaining to the practical applicability of the experiment results. First, the study on voluntary carbon offsetting did not examine possible adverse effects of message framing on pro-environmental behaviour. Two such effects examined in other domains and for other types of nudges are psychological reactance and negative spillovers onto behaviour within or across domains. The former pertains to the negative emotional state resulting from the individual noticing the intention and feeling manipulated from it (Brehm, 1966; Bruns et al., 2018). This may lead to boomerang or pushback effects, whereby the individual engages in opposite ('deviant') behaviour. For voluntary carbon offsetting, in particular, individuals may be especially averse to flight companies encouraging offsetting by illustrating damage to the environment from flying. This has been categorised as 'misleading' in Guix et al.'s (2022) voluntary carbon offsetting communication framework, and may be seen by some as greenwashing (Raji, 2022). Unfortunately, encouraging voluntary carbon offsetting post-purchase (e.g. directly from third-party provider) may be more difficult as, as a recent survey found, the majority of people prefer to offset directly during the flight booking process (Eslaminassab and Ehmer, 2021).

Negative spillovers may include moral licensing, the phenomenon whereby an individual uses moral or good behaviour in one domain to justify less moral behaviour in another domain (Merritt et al., 2010). For instance, appeals with loss framing may lead an individual to recycle more, which he would in turn use to justify traveling to work by car, thinking he has "done his part for the environment". In a field experiment on spillover effects of a household energy conservation programme, Tiefenbeck et al. (2013) found that a decrease in water use is followed by an almost commensurate increase in electricity consumption. When it comes to financial payments to a general charity, individuals may be less likely to indicate intention to donate to environmental charities (Meijers et al., 2015). A similar finding follows from my own study, where I show that offsetting behaviour is negatively associated with past donation to environmental causes (though, less congruently, not with past purchase of voluntary carbon offsets).

Voluntary carbon offsetting itself may also lead to moral licensing. In particular, after offsetting their flight, tourists may behave less pro-environmentally at their destination, though this has to my knowledge not yet been empirically investigated.

Like other nudges (particularly System 1 nudges), loss framing may be less effective in maintaining pro-environmental behaviour in the long run (Michalek et al., 2015). Since behaviour is a subconscious reaction to an intervention, cultivating the behaviour requires not only retaining the intervention, but also ensuring it does not lose traction. This suggests estimates of loss framing effects that are measured directly after the message is received by the decision-maker could be overstated and less generalizable. Unfortunately, neither my own experiment, nor the empirical studies reviewed in chapter 2.2, provide implications for long term behavioural change and habit formation, two critical issues in applied behavioural economics.

The final practical limitation of this thesis pertains to the dynamic nature of the tourism and travel context. Since 2020, the Covid-19 pandemic led to travel and hospitality restrictions across the globe (UNWTO, 2020). For different destinations these included closed borders, restrictions on within-country mobility, cancellation of events, and closure- or capacity limitation of hotels, restaurants, cultural sites and entertainment venues, among others (Gursoy and Chi, 2020; Hale et al., 2020). What is most relevant here, at one point in time, restrictions on air travel led to the cancellation of around 70% of all flights (European Court of Auditors, 2021). This may impact the practical applicability of the loss framing experiment because people with at least one cancelled flight could be less inclined to purchase a voluntary carbon offset for their next trip, since a cancelled and thus foregone flight has already contributed to a reduction in expected carbon dioxide emissions. The control variable for Covid-19, which captures potential past flight cancellation, did not have a statistically significant effect on offsetting behaviour in my experiment. Nevertheless, I cannot exclude its possibility in practice altogether.

At the time of writing, in autumn 2022, another external risk looms even larger: the predicted recession in the EU (Economist, 2022)[16]. Studies have shown that in a recession, people are less likely to donate to charity (Rooney and Bergdoll, 2020), and this includes environmental charities, with more than half of them reporting having been negatively affected by economic downturn (Charity Commission, 2010). The adverse wealth shock may also impact purchasing behaviour of (the often more expensive) goods with a lower negative environmental impact, but it may also lead to improved household water and energy efficiency. The question of relevance here, though, is whether this wealth effect interacts with loss aversion; that is, whether individuals are more or less loss averse when it comes to environmental goods in times of recession.

5.6 Direction for future research

Following from the paucity of existing studies with real behaviour as their outcome variable, I would encourage more researchers to investigate the effect of loss and gain framing on behaviour directly, rather than through stated preferences. I would urge particular caution

[16] Another external risk to air travel as of time of writing is the Russian invasion of Ukraine, but any potential effects on pro-environmental behaviour are weak or indirect.

when inferring post-study behaviour from behavioural intention. That studies overwhelmingly measure preferences is understandable from a practical standpoint as measuring behaviour requires more resources and carries a higher level of risk of implementation. However, it throws a worrying light on the external validity of results and applicability of tested interventions.

I would follow the recommendations of researchers before me (White et al., 2011; Amatulli et al., 2019) and encourage more testing of when and why framing works, both to advance theoretical understanding and success in practice. It may be interesting to compare and contrast reactions to message framing across green behaviour types. Indeed, the variation in the effort required, associated financial costs, and perceived benefits to the environment, the self and the society may lead to different effectiveness of gain and loss framing, not least when measuring (the more conscious) stated preferences. It would also be of value to empirically establish whether framing effects persist in the long run, and whether they trigger negative side-effects, namely environmentally-damaging behaviour following moral licensing or psychological reactance effects.

Looking at voluntary carbon offsetting research in particular, the numerous existing studies in this area are a treasure chest for understanding individual preferences surrounding offsetting, in particular as pertaining to the project attributes people would be happy to finance and how much they would be willing to pay to do so. I would suggest building on this research to examine how actual rather than hypothetical willingness to pay varies across project and message characteristics. I also propose to bring voluntary carbon offsetting experiments to the field: partnerships with an airline, travel agent or other transport company to experiment with differently framed messages on the reservation website would bring a refreshing dose of realism to our collective understanding of voluntary carbon offset take-up.

Experimental research that uses different methods to understand whether (and which) nudges take effect at the subconscious level and which ones are deliberated upon are still scarce. Yet such findings would bring immense theoretical and practical value, since they have implications for how these nudges can most effectively be rolled out. This could be done experimentally by examining response times, manipulating response times, adding questions prompting reflection (as attitude questions did here), or allowing participants to revise their initial decision. A valuable avenue for further research are also the cognitive foundations of loss aversion and its effects on pro-environmental decisions. Here I see an important role of neuroeconomics. Research questions that can be addressed through neuroscientific methods include whether loss averse behaviour is driven by negative emotions, by decision-making myopia, by risk aversion, and so on.

A final suggested avenue for future research would be to test other aspects of prospect theory in the environmental domain, and in particular other manifestations of loss aversion (endowment effect, default bias). By bringing this together with loss framing, we would collectively gain a more holistic understanding of loss aversion when it comes to pro-environmental behaviour.

CONCLUSION

This thesis has brought together loss aversion – a theoretical construct rooted in behavioural economics – with pro-environmental behaviour and tourism. It started with four sections exploring the literature and theories relevant to the topic, among them a systematic literature review on framing effects on pro-environmental decisions, which provided an inventory and characterisation of the current state of the framing research. The review showed that loss framing was more likely to lead to change in the measured outcome than gain framing. Importantly, it was much more likely to lead to pro-environmental behaviour, though gain framing was associated with more positive attitudes towards the behaviour or message.

These findings from the review were built on in the empirical part of the dissertation. The study reported on in chapters 3-5 examined real behaviour responses to the behaviourally-informed intervention of loss framing. The experimental design of the study made a methodological contribution in bringing in good practice from experimental economics to travel and tourism studies. To the extent of my knowledge, real effort tasks have not yet been used in this field and represent a useful method for generating income within the experiment that the participant can then allocate as he would in the real world. By carrying out a controlled experiment with financial incentives and real-world consequences I could also control for possible confounds and investigate a potential causal link between the loss-framed message and decisions to contribute to climate change mitigation. By also measuring attitudes and intention, I was able to confirm the existence of a gap between the two stated preference variables and behaviour.

The empirical study found loss framing to have a statistically significant effect on pro-environmental behaviour only when the offsetting decision preceded questions on attitude. The results and the discussion that followed contribute a number of interesting theoretical insights: from providing new (partial) real-behaviour evidence on loss framing in the environmental domain, to investigating the cognitive foundations of behaviour, to quantifying and analysing the gap between attitudes and intention, on the one hand, and behaviour on the other. Through this I also showed the importance of the researcher's decision on measurement instruments and warned against drawing definitive practical implications from stated-preference results alone.

To answer the research question defined at the outset, the findings in this thesis suggest that loss aversion does have an effect on pro-environmental decisions. This is supported by evidence on the effects of loss framing on pro-environmental decisions gathered in the systematic literature review, and, partially, the experimental study presented in this dissertation. In other words, when making environmentally-relevant decisions, people seem to be more averse to how these may damage the environment than they are inclined to positively change it.

The finding implies that messages that highlight the negative consequences of a decision on the environment are more likely to lead to behavioural change than messages that highlight the positive consequences of the opposite decisions. To policy makers and businesses seeking to encourage pro-environmental behaviour, this suggests introducing or manipulating an

existing description so it presents the negative outcomes of not carrying out a pro-environmental action. Choice architects would also be advised to place the framed description temporarily and/or physically next to the desired behaviour, rather than as part of an information campaign. For instance, travel agents may decide to rephrase descriptions of voluntary carbon offsets that accompany the option to purchase them directly at the point of reservation of air travel or other public transport tickets online. Elsewhere in the domain of pro-environmental behaviour, this may mean placing loss-framed environmental appeals on recycling bins to encourage recycling, in hotel bathrooms to encourage reductions in water use or next to air conditioner displays to encourage more frugal energy. A number of these interventions have already been implemented by private sector stakeholders. This thesis has sought to go beyond that: by combining practical use with theoretical value, I believe I was able to offer some interesting and important insights to policy makers and researchers who seek to better understand and improve pro-environmental behaviour in the real world.

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APPENDICES

Appendix 1: Summary in Slovenian language/ Daljši povzetek disertacije v slovenskem jeziku

Preučitev učinkov nenaklonjenosti izgubi na sprejem okolju prijaznih odločitev

Uvod

Varovanje okolja je eden največjih izzivov, s katerimi se človeštvo srečuje danes. V letih od 2021 do 2022 je Medvladni odbor za podnebne spremembe (IPCC) objavil najbolj skrb vzbujajoča poročila doslej, zaradi česar je generalni sekretar Združenih narodov António Guterres razglasil »rdečo kodo za človeštvo« (Združeni narodi, 2021). Kar 11 000 znanstvenikov iz več kot 160 držav in več kot 2.000 nacionalnih ter podnacionalnih jurisdikcij je razglasilo izredne podnebne razmere (Deklaracija o podnebnih spremembah, 2021; Ripple et al., 2019). Ti odzivi so sledili zaznavi visokih koncentracij ogljikovega dioksida in drugih toplogrednih plinov v ozračju na ravneh, ki so najvišje doslej (IPCC, 2021) in dvakrat večje od tiste, ki jo je okolje zmožno absorbirati (NOAA, 2022). Spreminjajoče se podnebne razmere ogrožajo okoljsko (ter družbeno in gospodarsko) trajnost kot tudi ekosisteme, biotsko raznovrstnost, vire hrane, vodo in druge naravne vire, ne nazadnje tudi naše zdravje, fizično in ekonomsko varnost.

S ciljem ublažitve posledic človekovega negativnega vpliva na okolje potrebujemo multidisciplinaren pristop in sodelovanje vseh deležnikov: oblikovalce vladnih politik, da oblikujejo in izvajajo potrebne ukrepe; znanosti, da razvije okolju prijazne rešitve; podjetij, da prilagodijo proizvodne prakse; in nas, posameznikov, da spremenimo svoje vedenje. Pričujoča disertacija se osredotoča na posameznike kot neodvisne odločevalce in na to, kako lahko na naše vedenje vplivajo ukrepi deležnikov iz zasebnega ali javnega sektorja.

Tradicionalni ekonomski modeli predvidevajo, da imajo ljudje racionalne preference in sprejemajo odločitve, ki glede na omejena sredstva pripeljejo do optimalnih rezultatov. Skladno s tem je odločanje možno izboljšati s povečanjem izbire, spreminjanjem privlačnosti različnih možnosti ali zagotavljanjem več informacij (Frederiks et al., 2015). Oblikovalci politik se, tako posredno kot tudi neposredno, opirajo na te predpostavke: med političnimi instrumenti najdemo prepovedi in predpise, ki spremenijo izbiro, subvencije in obdavčitve, ki predrugačijo strukturo spodbud, ter informativne in izobraževalne kampanje, ki izboljšajo poznavanje možnosti, ki so na voljo.

Vendar, izhajajoč iz spoznanj sodobnih raziskav s področja psihologije in vedenjske ekonomije, posamezniki odločitev ne sprejemajo racionalno: njihovo vedenje pogosto temelji na hevrističnem odločanju, ki sistematično odstopa od tradicionalnih ekonomskih predpostavk (Tversky in Kahneman, 1974). Kahneman in Tversky (1979) sta združila številne opažene pristranskosti v ekonomski model ter zasnovala t. i. *teorijo obetov* (*angl.* prospect theory) kot alternativo teoriji pričakovane koristi (von Neumann in Morgenstern,

1944) za preučevanje odločanja v kontekstu negotovosti. Glavne značilnosti predlagane teorije so: odvisnost od referenčne točke (dobički in izgube so opredeljeni glede na referenčno točko), padajoča občutljivost (mejna vrednost izgub in dobičkov se zmanjšuje z velikostjo teh) ter *nenaklonjenost izgubi* (*angl.* loss aversion). Slednja pomeni, da je odpor proti izgubi večji od želje po pridobitvi koristi enake vrednosti in je še posebej zanimiva pri preučevanju okoljskih odločitev. Medtem ko so številni avtorji (npr. Kahneman et al., 1990) dokazali nenaklonjenost izgubi pri odločitvah, ki vplivajo na odločevalca, je manj jasno, če je enako prisotna tudi pri kolektivnih dobrinah, kot je okolje. Za preučitev tega pojava bomo uporabili z nenaklonjenostjo izgubi povezano *vrednostno okvirjanje* (*angl.* valence framing). Vrednostno okvirjanje semantično preoblikuje sporočilo, tako da je predstavljeno bodisi v pozitivni bodisi v negativni luči (Levin et al., 1998), s čimer ljudi, ki imajo večjo nenaklonjenost izgubi, vodi do želene izbire (Avineri in Owen, 2013). Osredotočili se bomo na *ciljno okvirjanje* (*angl.* goal framing), pri katerem se podajanje informacij razlikuje glede na to, ali kot rezultat nekega dejanja prikazuje korist ali izgubo (Levin et al., 1998). To nam ne omogoča samo testiranja, ampak tudi izkoriščanje nenaklonjenosti izgubi za doseganje različnih ciljev. Uporaba ciljnega okvirjanja v kontekstu okolju prijaznih odločitev predstavlja teoretično izhodišče te disertacije.

Pričujoča disertacija se osredotoča na področje potovanj in turizma, ki je pri raziskovanju okolju prijaznih odločitev posameznikov še posebej pomemben, saj turistična panoga dejavnosti k emisijam toplogrednih plinov kot glavnemu povzročitelju podnebnih sprememb prispeva kar 8% delež (Lenzen et al., 2018). Pričakujemo, da nam bodo teoretična izhodišča in metode, uporabljene v vedenjski ekonomiji, med njimi zlasti ciljno okvirjanje (Levin et al., 1998), pomagali pri raziskovanju negativnega vpliva turizma na okolje.

Pregled literature

Okoljska vedenjska ekonomija, kamor se uvršča ta doktorska disertacija, je podveda vedenjske ekonomije, ki se ukvarja z raziskovanjem vpliva različnih kognitivnih pristranskosti na okolju prijazno vedenje ter kako to lahko uporabimo za oblikovanje učinkovitejših okoljskih politik, pa tudi z vedenjsko teorijo iger za preučitev pogajanj o podnebnih spremembah, tveganimi odločitvami in netržnim vrednotenjem (Shogren, 2012), ki so manj povezana s temo te disertacije. Eden od prvotnih konstruktov v vedenjski ekonomiji in jedro teorije obetov je nenaklonjenost izgubi (Kahneman in Tversky, 1979). Gre za pojav, ki označuje težnjo posameznikov, da se bolj izogibajo izgubi, kot zasledujejo korist enake vrednosti. Implicitno je bilo za razvoj teorije obetov uporabljeno znanje o dveh kognitivnih sistemih, formalizirano v teoriji dualnega procesiranja (Kahneman, 2011). Omenjena teorija predvideva, da obstajata dva kognitivna procesa, ki se lahko aktivirata, ko posameznik sprejema odločitev: hiter in samodejen (sistem 1) ter počasen in premišljen (sistem 2) (Evans in Stanovich, 2013). Na podlagi spoznanj teorije dualnega procesiranja lahko bolje razložimo vrzel med stališči in vedenjem, saj je za vedenje pogosto odgovoren samodejni kognitivni sistem, za izražanje stališč pa počasni kognitivni sistem.

Teorija dualnega procesiranja služi tudi kot izhodišče za aplikativni del vedenjske ekonomije – dregljaje. Dregljaj (*angl.* nudge) je vsak vidik konteksta (oziroma »arhitekture«) odločitve, ki spremeni vedenje ljudi na predvidljiv način, ne da bi pri tem omejeval možnosti ali pomembno spremenil finančne spodbude (Thaler in Sunstein, 2009). Dregljaji lahko ciljajo na aktivacijo sistema 2, na primer s sporočili in drugimi spremembami okolja, ki posameznika prisilijo k razmisleku o dejanju. Tovrstni dregljaji so lahko koristni tam, kjer ima posameznik visoko stopnjo skrbi za okolje, saj že obstoječa okolju prijazna stališča spremenijo v okolju prijazna dejanja. Po drugi strani pa se pri posameznikih z nizko stopnjo skrbi za okolje lahko uporabijo dregljaji, ki ciljajo na sistem 1, kot so intervencije, ki zaobidejo obstoječa stališča. Okvirjanje izgube v okoljskem sporočilu lahko zaradi svoje neočitnosti deluje zlasti kot dregljaj sistema 1 in s tem vpliva na podzavestno odločanje posameznika.

Sistematičen pregled literature kaže, da ima na področju okolju prijaznega vedenja okvirjanje posledice okolju relevantne odločitve kot izgubo res večji učinek v več primerih kot okvirjanje nasprotnega fenomena kot korist. V 30 od 61 študij, ki sem jih pregledala, se je okvirjanje izgube izkazalo za uspešnejše; okvirjanje koristi je bilo uspešneje v 18 študijah (pri preostalih sta bili okvirjanji enako uspešni).

Avtorja Avineri in Waygood (2013), na primer, ugotavljata, da ljudje drugače zaznavajo enake količine izpustov CO_2 glede na to, ali so te predstavljene v pozitivnem ali negativnem okvirju. Pri raziskovanju recikliranja s strani posameznikov avtorji (Lord, 1994; Davis, 1995) ugotavljajo, da negativno okvirjeni pozivi vodijo do večjega recikliranja oziroma namere za njegovo izvajanje. Predhodne raziskave so raziskale tudi pogoje, v katerih je negativno okvirjanje uspešnejše. Amatulli et al. (2019) so izvedli štiri eksperimente na posameznih kupcih, v katerih so preučevali vpliv interakcije med okvirjanjem sporočila in izzvanimi čustvi na namero za sprejetje okolju prijazne odločitve (nakup okolju bolj prijaznih izdelkov). Ti avtorji so ugotovili, da so negativno okvirjena sporočila pri tem uspešnejša od pozitivno okvirjenih, in sicer zaradi občutka sramu, ki ga izzovejo.

Med preučevanimi spremenljivkami vpliva najdemo še stopnjo interakcije s sporočilom (Ahn et al., 2015) in psihološko ali geografsko bližino vpliva. Pri slednjih so raziskovalci (npr. White et al., 2011; Chang et al., 2015) ugotovili, da je negativno okvirjanje uspešnejše, ko je združeno s proksimalnimi časovnimi konstrukti ali konkretnimi informacijami, medtem ko pozitivno okvirjena sporočila bolje delujejo skupaj z oddaljenimi časovnimi konstrukti ali abstraktnimi informacijami.

Konkretno za področje turizma so Blose et al. (2015) ugotovili, da negativno okvirjena sporočila močneje vplivajo na namero za ponovno uporabo posteljnine s strani hotelskih gostov, s čimer prispevajo k nižji porabi vode. Iz dveh študij avtorjev Grazzini et al. (2018) prav tako izhaja, da so negativno okvirjena sporočila uspešnejša, ko so raziskovali vedenje gostov v hotelih v povezavi z recikliranjem.

Obstoječa literatura preučuje predvsem vpliv okvirjanja na odnose do okolja in namere za izvajanje določenega vedenja. Dejansko vedenje uporabnikov kot posledice preusmeritve

okvirjenega sporočila meri zelo malo študij: v samo 7 od 61 študij, ki so zaobjete v sistematičnem pregledu literature, so avtorji merili dejansko vedenje. V šest od sedmih študij je bilo uspešno okvirjanje izgube, v eni pa nobeno okvirjanje ni pomagalo k bolj okolju prijaznem vedenju.

Kot pri drugih študijah s področja okoljske psihologije se tudi na področju turizma raziskovalci osredotočajo na okolju prijazna stališča in vedenjske namere, zanemarjajo pa dejansko vedenje. Pri tem se večinoma naslanjajo na teorijo načrtovanega vedenja, glede na katero je vedenje vedno rezultat zavestnih in premišljenih odločitev, ki odražajo stališča. Vendar se je pokazalo, da se stališča in vedenje razlikujejo ter da je ta vrzel v turističnem kontekstu še večja (Barr, 2010). Razlogi za to vključujejo odsotnost ustrezne infrastrukture (Wu et al., 2021), drugačne institucionalne sisteme, norme in predpise v tujini kot doma (Juvan in Dolničar, 2013), navsezadnje tudi navade (Miller et al., 2015) in izgovore, povezane s subjektivno hedonistično izkušnjo potovanja (Juvan in Dolničar, 2014). Ne glede na to pa se vse več študij v turizmu naslanja na spoznanja vedenjske ekonomije in preizkuša vpliv različnih dregljajev na dejansko okolju prijazno vedenje turistov. Dregljaji, povezani z nenaklonjenostjo izgubi, poleg okvirjanja izgube vključujejo tudi pristranskost privzete možnosti (*angl.* default bias). Omenjeni dregljaj se je izkazal za uspešnega pri spodbujanju odpovedovanja dnevnega čiščenja sob v hotelih (Knezevic Cvelbar et al., 2021), pri uporabi serviet iz recikliranega papirja z manj emisijami CO_2 namesto bombažnih (Dolničar et al., 2019), pri podpori politikam za blaženje podnebnih sprememb s strani turistov (Arana et al., 2012) in pri nakupu prostovoljnih izravnav ogljika (Arana in Leon, 2012). Prav slednje je predmet empirične raziskave pričujoče doktorske disertacije.

Z namenom empirične preveritve učinka okvirjanja na okolju prijazno vedenje je bil potreben izbor ene vrste okolju prijaznega vedenja turistov. Sama sem se osredotočila na nakup prostovoljne izravnave ogljika. Tema je zanimiva, saj emisije od letalskega prevoza predstavljajo med 2 in 3,5 % vseh emisij toplogrednih plinov (Lee et al., 2021; UNWTO, 2019), hkrati pa je sámo zmanjšanje letenja zaradi njegovega vpliva na turizem številnih držav po svetu tako neizvedljivo kot tudi škodljivo za globalno gospodarstvo in zaposlenost. Poleg tega je prednost prostovoljne izravnave ogljika ta, da se tudi sicer izvaja prek spleta, kar pomeni, da spletni eksperiment lahko kar najbolje približam okoliščinam odločitve v praksi.

Pri izravnavi ogljika gre za zmanjšanje emisij ogljikovega dioksida ali drugih toplogrednih plinov v ozračje z namenom kompenzacije emisij CO_2 s strani lastne aktivnosti (Carbon Offset Guide, n.d.). Projekti za zmanjšanje emisij toplogrednih plinov vključujejo pogozdovanje ter investicije v energetsko učinkovite gospodinjske aparate in obnovljive vire energije. Izravnava ogljika je lahko obvezna ali prostovoljna. Trg prostovoljnih izravnav ogljika je bil v letu 2020 vreden 473 milijonov ameriških dolarjev (FTE Marketplace, 2021), s čimer je občutno manjši od trga obvezne izravnave ogljika (vreden 238 milijard ameriških dolarjev v istem letu). Napovedi za naprej so velikopotezne: rast povpraševanja po nakupu prostovoljne izravnave ogljika do leta 2050 je ocenjena na do 50 milijard ameriških dolarjev, odvisno od cenovne politike (Blaufelder et al., 2021). Navkljub temu pa je glede na število

letov delež nakupa vztrajno nizek: zgolj 1 do 3 % potnikov se odloči za nakup prostovoljne izravnave ogljika neposredno pri nakupu letalske vozovnice.

V literaturi so raziskovalci odkrili različne dejavnike nagnjenosti k nakupu prostovoljne izravnave ogljika, ki jih lahko uvrstimo v naslednje kategorije: socialno-demografske značilnosti posameznika, njegove navade, vezane na letenje in odnos do okolja, njegovo predhodno znanje o vplivu letenja na okolje ali o prostovoljni izravnavi ogljika, njegove psihološke dejavnike, kot so norme in stališča, značilnosti izleta, značilnosti projekta, ki ga nakup prostovoljne izravnave ogljika financira, cena prostovoljne izravnave ogljika ter kontekst nakupa. Raziskovalci so v spletnih poskusih diskretne izbire največkrat raziskovali vpliv spremembe značilnosti projektov, kot so vrsta projekta (Choi et al., 2018; Rotaris et al., 2020), certificiranost s strani vlade (Blasch in Farsi, 2014) in obstoj pozitivnih eksternalij na lokalno prebivalstvo (MacKerron et al., 2009; Zhang et al., 2021). Nekaj poskusov je bilo tudi narejenih na podlagi dognanj iz vedenjske ekonomije, in sicer so Huber et al. (2018) in Loschel et al. (2013) raziskali vpliv družbenih norm na nakup prostovoljne izravnave ogljika, Arana in Leon (2012) in Kesternich et al. (2019) pa vpliv pristranskosti prevzete izbire. Vpliv okvirjanja izgube na (dejanski) nakup prostovoljne izravnave ogljika v literaturi še ni bil raziskan.

Raziskovalni cilji

Pričujoča doktorska disertacija bo preučila, ali posamezniki izkazujejo nenaklonjenost izgubi, ko gre za okoljske spremembe, ter kako lahko to oblikovalci okolju relevantnih ukrepov koristijo, da okrepijo okolju prijazno vedenje. Ključni kontekst bo letalski promet v okviru globalnega turizma.

Specifični cilji disertacije so naslednji:

- razumevanje, kako je nenaklonjenost izgubi povezana z okolju prijaznim vedenjem;
- zbiranje obstoječih dokazov o učinku okvirjanja izgube in koristi na okolju prijazne odločitve;
- analiza in organizacija teh dokazov z namenom opredelitve pogojev, pod katerimi okvirjanje sporočila kot izguba ali korist pozitivno prispeva k okolju prijaznemu vedenju;
- eksperimentalni preizkus učinka okvirjanja izgube in koristi na okolju prijazne odločitve s spodbudami združljivem spletnem okolju;
- identifikacija morebitnih vrzeli med okolju prijaznimi stališči in vedenjem ter med okolju prijaznimi namerami in vedenjem v istem eksperimentalnem okolju;
- zbiranje različnih teoretičnih razlag za izsledke eksperimenta;
- predlog ukrepov za oblikovalce politik na podlagi lastnega eksperimenta in izsledkov drugih raziskav.

Metodologija

Z namenom doseganja raziskovalnih ciljev sem najprej raziskala glavni konstrukt disertacije (nenaklonjenost izgubi), njegovo interakcijo z okolju prijaznim vedenjem in kontekst, v

katerem ga empirično raziskujem (turizem in, natančneje, prostovoljna izravnava ogljika). Predstavitev teh spoznanj sestavlja teoretično komponento disertacije in vključuje:

- raziskovanje teoretičnih temeljev za nenaklonjenost izgubi ob sprejemanju okolju relevantnih odločitev;
- sistematičen pregled literature okvirjanja izgube na okolju prijazne odločitve;
- osredinjen pregled okoljske trajnosti v raziskavah v turizmu, ki so relevantne za to disertacijo;
- pregled podatkov in literature o prostovoljni izravnavi ogljika.

Empirična komponenta doktorske disertacije je sestavljena iz spletnega eksperimenta, ki meri dejansko vedenje, in predtestov, osnovanih na pristopu mešanih metod.

Prednost spletne izvedbe eksperimenta je v tem, da omogoča merjenje stališč, vedenjskih namer in dejanskega vedenja v istem okolju, obenem pa tudi njegova ponovljivost in možnost hitrega pridobivanja udeležencev, ki prihajajo iz heterogenih družbenih skupin (Birnbaum, 2004). Študija je bila izvedena v obliki randomiziranega kontrolnega eksperimenta, v katerem so bili udeleženci enakomerno razdeljeni v dve testni skupini in eno kontrolno skupino. Z namenom približanja odločitve v eksperimentu odločanja v resničnem svetu sem v študijo vključila nalogo z dejanskim dohodkom za udeležence. Gre za pogosto uporabljeno orodje v eksperimentalni ekonomiji, ki pa po mojem vedenju še ni bila izvedena v študijah turizma. Komponenta dejanskega vedenja v študiji je bila odločitev o tem, ali zaslužek od naloge uporabiti za nakup prostovoljne izravnave ogljika.

Da bi udeležencem zagotovila pravilno razumevanje poskusa in anketnega vprašalnika, ki mu je sledil, sem izvedla tri predteste. Kvalitativni predtest je bil sestavljen iz fokusne skupine, v kateri so udeleženci razpravljali o mnenjih in izkušnjah s prostovoljno izravnavo ogljika. Protokol ciljne skupine je vključeval tudi preverjanje manipulacije za potrditev pravilne razlage okvirov izgube in izboljšanja opisa prostovoljne izravnave ogljika. Kvantitativna faza predtesta je obsegala anketo za preverjanje ustreznosti posameznikov za sodelovanje in pilotne teste. Namen prve je bil izločiti posameznike, ki niso upravičeni do študije in njenih pilotov. Nato sta bila izvedena dva kroga pilotnih testov, s katerimi sem želela preveriti predvideno manipulacijo okvirja in preizkusiti razumljivost uporabljenih izrazov.

Za analizo sem najprej izvedla preprosto navzkrižno tabeliranje s hi-kvadrat statističnim testom, da sem lahko definirala profile tistih, ki so se odločili za prostovoljno izravnavo ogljika. S tem sem ugotovila, katere posamezne značilnosti (socialno-demografske skupine, navade, vrednostne usmeritve, prepričanja in podobno) so povezane s pozitivnim stališčem do prostovoljne izravnave ogljika in z večjo verjetnostjo njegovega nakupa v okviru študije. Da bi preizkusila svoje hipoteze, sem nato izvedla linearno regresijo učinkov okvirjanja na stališča in binarno logistično regresijo učinkov okvirjanja na vedenje. Vrzeli med stališči in vedenjem ter namero in vedenjem sem izračunala s statističnimi testi sorazmernosti. Številne druge statistične tehnike so bile uporabljene tudi v fazah priprave in validacije podatkov ter za pregled rezultatov hipotez.

Ključna spoznanja

Analiza profilov posameznikov, ki so se odločili za nakup prostovoljne izravnave ogljika znotraj študije, razkriva zgolj eno statistično značilno razliko med njimi in tistimi, ki se za nakup niso odločili, tj. politično usmeritev. Če sem bolj natančna, pri posameznikih na bolj levi strani političnega pola je bila verjetnost nakupa večja, kar je usklajeno s predhodnimi raziskavami, kjer so ugotovili, da je leva politična ideologija močneje povezana z okolju prijaznim vedenjem (Klein et al., 2019).

Na stališče udeležencev ankete do prostovoljne izravnave ogljika ni vplivalo niti okvirjanje izgube niti okvirjanje koristi. Gre za nekolikšen kontrast s predhodno literaturo, kjer je okvirjanje koristi največkrat statistično značilno vplivalo na okolju prijazna stališča (Homar in Cvelbar, 2021). Eden od možnih razlogov za ta rezultat je, da je bil element prepričljivost v opisu prostovoljne izravnave ogljika preblag, da bi lahko vplival na stališče. To je sicer skladno z mojim ciljem, tj. udeležencem predstaviti vrednostno nevtralni opis, kar pa je bilo premalo za (pre)oblikovanje posameznikovega stališča do izravnave ogljika. Tako je ta spremenljivka zajela le že obstoječa stališča do prostovoljne izravnave ogljika. S pozitivnim stališčem pa so bile pozitivno statistično značilno povezane naslednje spremenljivke: subjektivne norme, visoka okoljska vrednostna usmeritev, zaupanje v organizacije za prostovoljno izravnavo ogljika in ženski spol udeleženke.

Rezultati razkrivajo tudi, da je imelo okvirjanje izgube statistično značilen učinek na izbiro za nakup prostovoljne izravnave ogljika (spremenljivko vedenja) samo pri enem anketnem vrstnem redu. Udeleženci, ki so prebrali sporočilo z okvirjeno izgubo, so bili bolj dovzetni za nakup prostovoljne izravnave ogljika kot udeleženci iz preostalih dveh testnih skupin pri anketnem vrstnem redu, v katerem je izvedba naloge z odločitvijo o razporeditvi zaslužka neposredno sledila opisu na začetku. Ena od možnih razlag za dvoumnost rezultatov v nasprotju s tistimi iz drugih študij o učinkih okvirjanja (90 % jih je ugotovilo, da okvirjanje izgube pozitivno vpliva na okolju prijazno vedenje; Homar in Cvelbar, 2021) leži v stroških, povezanih z vedenjem pri tej študiji. V nobeni od prejšnjih študij udeleženci niso utrpeli finančne izgube kot posledice izbire okolju prijaznega vedenja. Nasprotno pa je študija, ki je predmet te disertacije, podobno kot v resničnem svetu od udeležencev zahtevala, naj sprejmejo finančno odločitev, ki ima za posledico izgubo zaslužka.

Odvisnost statističnega učinka od vrstnega reda ankete bi bila lahko rezultat dualnosti kognitivnega procesiranja: okvirjanje izgube je delovalo kot dregljaj sistema 1, tj. dregljaj, ki cilja na hitre in podzavestne procese odločanja; zaradi prej postavljenih vprašanj o stališčih pri drugem vrstnem redu ankete je odločitev, komu nameniti zaslužek, postala bolj premišljena, zaradi česar je oblikovanje izgube kot dregljaj izgubilo svoj učinek.

Druga pomembna ugotovitev eksperimenta je, da obstaja vrzel med stališčem do prostovoljne izravnave ogljika in vedenjem: ne samo da pozitiven odnos ni bil vedno povezan z vedenjem, ampak je pri številnih udeležencih negativno stališče *bilo* povezano z vedenjem, tj. z odločitvijo za izravnavo ogljika. To nakazuje, da pozitivno stališče ni predpogoj za okolju

prijazno vedenje, ugotovitev, ki je v nasprotju z implicitnimi predpostavkami v literaturi, ki se opirajo na teorijo načrtovanega vedenja (*angl.* theory of planned behaviour).

Rezultati prav tako kažejo na vrzel med namero in vedenjem. Konkretno je le 46 % udeležencev, ki je izrazilo namero po prostovoljni izravnavi ogljika, to dejansko naredilo (preostali so prihodke, zaslužene z nalogo, vzeli zase). Številne teoretične razlage, podane v literaturi, lahko izključimo: infrastrukturnih ali institucionalnih omejitev (Kollmuss in Agyeman, 2002) pri eksperimentu ni bilo, prav tako ne pomanjkanje priložnosti za izvedbo (Sheeran, 2002). Za boljše razumevanje vrzeli se lahko spet naslonimo na teorijo dualnega procesiranja, ki pravi, da so lahko odločitve posledice različnih kognitivnih sistemov. Za dotični eksperiment bi to pomenilo, da so bile izražene namere za nakup prostovoljne izravnave ogljika posledica zavestnega in premišljenega odločanja (sistema 2), dejanski nakup oziroma njegova odsotnost pa posledica hitrega in samodejnega odločanja (sistema 1). Ta rezultat lahko služi kot opozorilo raziskovalcem, da se ne zanašajo na meritve vedenjske namere kot indikatorja dejanskega vedenja.

Prispevki disertacije k znanosti in praksi

S temi rezultati se študija pridružuje obstoječim raziskavam o učinkih okvirjanja na okolju prijazno vedenje, ki v veliki večini ugotavljajo, da je okvirjanje izgube učinkovitejše pri spodbujanju želene vedenjske spremembe (Homar in Cvelbar, 2021). To je ena redkih študij, ki meri dejansko vedenje. Študija, predstavljena v tej disertaciji, je tudi edina, ki je raziskovala učinke okvirjanja posebej na (dejanski) nakup prostovoljne izravnave ogljika. Nazadnje je to tudi edina študija o okvirjanju izgube, pri kateri vedenje povzroči finančne stroške udeležencem. S tem se približa številnim odločitvam o vedenju v resničnem svetu, ki prav tako predstavljajo strošek za posameznika; poleg prostovoljne izravnave ogljika tu najdemo še nakup okolju prijaznejših dobrin (ki so pogosto dražje od alternativnih) ali donacijo okoljskim dobrodelnim organizacijam. Navkljub omenjenim stroškom se je okvirjanje izgube izkazalo za precej uspešno, kar je obetavno za njegovo uporabo v praksi.

Če se vrnemo k predmetu disertacije, tj. nenaklonjenost izgubi, lahko zaključimo, da dokazi o učinkih okvirjanja izgube na okolju prijazno vedenje, zbrani v sistematičnem pregledu literature in (delno) v lastni eksperimentalni študiji te disertacije, kažejo, da so posamezniki nenaklonjeni izgubam, ko gre za okoljske posledice odločitve. To pomeni, da se s svojim delovanjem bolj izogibajo negativnim okoljskim spremembam, kot pa iščejo sorazmerne pozitivne okoljske spremembe. To je zanimiva ugotovitev, ker je okolje večinoma javna in nedenarna dobrina, s čimer se po naravi razlikuje od denarnih dobrin zasebne lasti, na podlagi katerih je bila teorija obetov (in nenaklonjenost izgubi kot eden od osnovnih gradnikov) zasnovana.

Javnim in zasebnim deležnikom v turizmu na podlagi ugotovitev o učinkih okvirjanja izgube predlagam uvedbo ali manipulacijo obstoječega poziva k okolju prijaznemu vedenju v smeri predstavitve negativne posledice neizvajanja okolju prijaznega ukrepa. Prav tako bi jim svetovala, naj okvirjen opis časovno in/ali fizično postavijo poleg želenega vedenja namesto kot del informacijske kampanje. Potovalne agencije se lahko, na primer, odločijo

preoblikovati opise prostovoljne izravnave ogljika, ki spremljajo možnost njegovega nakupa neposredno na mestu spletne rezervacije letalskih ali drugih vozovnic za javni prevoz. Enako bi lahko naredile nevladne organizacije, ki jih prodajajo. Izsledki raziskave so lahko koristni tudi za druga področja okolju prijaznega vedenja; predlagam postavitev okoljskih pozivov, ki so okvirjeni kot izguba, na zabojnike za recikliranje, s čimer bi spodbudili recikliranje, v hotelskih kopalnicah, s čimer bi spodbudili zmanjšanje porabe vode, ali poleg zaslonov klimatskih naprav, s čimer bi spodbudili varčnejšo porabo energije. Nasprotno pa je oblikovanje izgube lahko manj učinkovito za spreminjanje vedenja, če se uporablja v izobraževalnih ali informacijskih kampanjah.

Kljub nekaterim pomanjkljivostim ponuja okvirjanje izgube v sporočilih uporabno dopolnilo obstoječim političnim instrumentom, ki ciljajo na zavestne miselne procese, kot so informacijske in izobraževalne kampanje, finančne spodbude ter regulacija. Cilj je zlasti aktivacija različnih ravni kognitivnega procesiranja in s tem različnih kanalov spreminjanja vedenja hkrati – podzavestnega vedenja neposredno, zavestnega pa s pomočjo preoblikovanja stališč in prepričanj.

Študija ima tudi nekaj teoretičnih in praktičnih pomanjkljivosti. Z vidika konteksta sem v svojem sistematičnem pregledu literature sicer zajela vse tipe (posameznikovega) okolju prijaznega vedenja, vendar sem se zaradi omejitev eksperimentalne metodologije osredotočila le na eno vrsto vedenja za sam eksperiment. Čeprav študije, ki merijo vedenje, v veliki večini podpirajo hipotezo o učinkovitosti okvirjanja izgube, njihovo nizko število (7) zahteva previdnost pri uporabi intervencij v praksi. Raznolikost 61 pregledanih študij, zlasti v smislu vrste okolju prijaznega vedenja, ki je v središču pozornosti, prav tako pomeni, da je vsak podvzorec precej majhen, kar omogoča oblikovanje posplošenih, vendar ne domensko specifičnih zaključkov. Enako velja za eksperiment o prostovoljni izravnavi ogljika, ki je bil izveden v okviru te disertacije.

S praktičnega vidika disertacija ni preučevala morebitnih škodljivih učinkov okvirjanja sporočil na okolju prijazno vedenje. Dva taka učinka, proučena na drugih področjih in za druge vrste spodbud, sta negativni psihološki ali čustveni odziv na dregljaj (Bruns et al., 2018) ter negativni učinki na vedenje znotraj ali med področji (Merritt et al., 2010). Tako kot drugi dregljaji (zlasti tisti, ki ciljajo na sistem 1) obstaja tveganje, da je okvirjanje izgube dolgoročno manj učinkovito pri ohranjanju okolju prijaznega vedenja (Michalek et al., 2015). Ker je vedenje podzavestna reakcija na dregljaj, negovanje vedenja ne zahteva le ohranjanja prisotnosti dregljaja, ampak tudi, da ta ne izgubi moči. Na žalost niti moj eksperiment niti empirične študije, pregledane v poglavju 2.2, ne navajajo posledic za dolgoročno spremembo vedenja in oblikovanje navad, kar sta kritični vprašanji uporabne vedenjske ekonomije.

Glede na pomanjkanje obstoječih študij, ki merijo vedenje, bi raziskovalce spodbudila, da raziščejo učinek okvirjanja izgube in koristi na vedenje neposredno, ne pa prek navedenih stališč ali namer. Na podlagi lastnih rezultatov o vrzeli med namerami in vedenjem pozivam k posebni previdnosti pri oblikovanju zaključkov za vedenje na podlagi izraženih namer. Druge bi spodbudila tudi k večjemu testiranju, kdaj in zakaj okvirjanje deluje, zlasti za

izboljšanje tako teoretičnega razumevanja kot tudi uspeha v praksi. Morda bi bilo zanimivo primerjati reakcije na okvirjanje sporočil med vrstami okolju prijaznega vedenja, saj se te razlikujejo glede na zahtevan napor, povezane stroške in obseg dokazanih koristi na okolje. Nazadnje predlagam tudi, da prihodnje raziskave preverijo vpliv drugih vidikov teorije obetov na okoljskem področju in zlasti drugih pojavov nenaklonjenosti (učinek lastništva, pristranskost, vezana na privzeto možnost). Skupaj z izsledki glede okvirjanja izgube bi tako dobili celovitejše razumevanje nenaklonjenosti izgubi, ko gre za okolju prijazno vedenje.

Appendix 2: Coding sheet for the systematic literature review

Category	Code	
Study	[Text]	
Authors	[Text]	
Year	[Text]	
Journal	[Text]	
Type of intervention	1 = goal framing 2 = attribute framing	
Independent variables	[Text] e.g. Gain / loss framing	
Type of loss aversion	1 = Environmental 2 = Monetary 3 = Health	4 = Societal 5 = Personal
Targeted outcome	Change in: 1 = behaviour 2 = beliefs 3 = intention	 4 = attitude 5 = willingness-to-pay 6 = other: _____
Relationship	1 = Correlational: [name of variable, if any] 2 = Causal: [name of variable, if any] 3 = Mediating: [name of variable, if any] 4 = Moderating: [name of variable, if any]	
Type of pro-environmental behaviour targeted	1 = Energy efficiency (purchase and usage) 2 = Water efficiency 3 = Waste and recycling 4 = Green consumption	5 = Transport use 6 = Pollution and climate change 7 = Biodiversity and conservation 8 = Other: _____
Method of data collection	1 = Field experiment 2 = Lab experiment 3 = Other experiment (e.g. online, survey)	4 = Survey 5 = Interviews
Measures used	[Text]	
Sample	[Number]	
Setting	1 = household 2 = travel / tourism 3 = work / school	4 = outside / nature 5 = unknown / irrelevant
Method of causal analysis	[Text]	
Results: summary	1 = Loss frame 2 = Gain frame	3 = Loss and gain frame 4 = Neither
Results	[Text] (+) or (-) to indicate direction; frame type → outcome	
Remarks	[Text] e.g. Limitations, long-run effects	

Appendix 3a: Systematic literature review empirical results: behaviour

Study	Independent variables	Dependent variable	Method	Context	Results
Authors, year, study number	• **Main variable** • **Moderating and secondary variables**	• **Outcome variable** • **Type of green behaviour**	**Method of data collection**	• **Country** • **Sample size** • **Sample characteristics**	**Summary – which frame is more effective** **Results** ***Explanation***
Ahn et al., 2015 (Study on behaviour)	● Goal framing ● Level of interactivity - moderating	● Behaviour ● Waste and recycling (paper use)	Laboratory experiment (concealed)	● United States ● 114 ● Students	**Neither** (0) Frame → paper napkin use *Compared to benchmark, both gain and loss framing led to lower paper napkin use (-25%), but with no difference in the effect between them.*
Gonzales et al., 1988	● Goal framing ● Use of visuals ● Personalisation ● Commitment device	● Behaviour ● Energy efficiency (usage tracked by smart meters)	Interviews	● United States ● 408 ● Households	**Loss frame** (-) Loss frame + vivid communication + customer commitment + personalisation → energy use *Together with moderators, loss frame led to lower energy use*
Grazzini et al., 2018 (Study 1)	● Goal framing ● Construal level - moderating	● Behaviour ● Waste and recycling	Field experiment	● United Kingdom ● 434 ● Hotel guests	**Loss frame** (+) Loss frame + concrete information {mod.} → recycling *Recycling behaviour was 11 p.p. higher in the loss than in the gain condition; the effect was greater when the information was concrete (22 p.p difference)*
Lord, 1994 (Study on behaviour)	● Goal framing ● Message source (advertising, publicity, personal)	● Behaviour ● Waste and recycling (curbside recycling)	Field experiment	● United States ● 140 ● Households	**Loss frame** (+) Loss frame + personal source {mod.}→ recycling *A negatively framed appeal conveyed by a personal acquaintance led to the highest increase in recycling; (any) messages conveyed by an advert also led to an increase in recycling, albeit smaller*
Nabi et al., 2018 (Study on behaviour)	● Goal framing ● Emotion - mediating	● Behaviour ● Pollution and climate change	Online experiment	● United States ● 337 ● Students	**Loss frame** (+) Loss frame → fear → advocacy behaviour *Loss framed messages had a significant effect on improved green intention, which was fully mediated by fear*
Poortinga and Whitaker, 2018	● Goal framing ● Financial incentives	● Behaviour ● Waste and recycling (use of reusable coffee cups)	Field experiment	● United Kingdom ● 12 ● Customers	**Loss frame** (+) Loss frame → sale share for reusable cups *The prospect of an additional charge had a greater effect on the share of sales for reusable (vs. non-reusable) cups than the prospect of a discount*
White et al., 2011 (Study 1)	● Goal framing ● Construal level - moderating	● Behaviour ● Waste and recycling (curbside recycling)	Field experiment	● Canada ● 390 ● Customers	**Loss frame** (++) Loss frame + concrete construal {mod.} → recycling (+40%) (+) Gain frame + abstract construal {mod.} → recycling (+20%) *A loss-framed appeal combined with concrete information on how to recycle led to a 40% increase in recycling compared to baseline (20 p.p higher than a gain-framed why-recycle message). After 6 months, the behaviour between the two groups converged.*

Appendix 3b: Systematic literature review empirical results: stated preferences

Study	Independent variables	Dependent variable	Method	Context	Results
Authors, year, study number	• **Main variable** • **Moderating and secondary variables**	• **Outcome variable** • **Type of green behaviour**	**Method of data collection**	• **Country** • **Sample size** • **Sample characteristics**	**Summary – which frame is more effective** **Results** ***Explanation***
Ahn et al., 2015 (Study on preferences)	● Goal framing ● Level of interactivity - moderating	● Intention, self-reported behaviour ● Waste and recycling (paper use)	Laboratory experiment	● United States ● 114 ● Students	**Gain frame** (+) Gain frame → [response efficacy →] intention (+) Gain frame → response efficacy → reported behaviour *The level of interactivity had no moderating effect, whilst response efficacy had a partial (full) mediating effect between the gain frame and intention (reported behaviour)*
Amatulli et al., 2019 (Study 1)	● Goal framing ● Emotions (anticipated shame or guilt) - mediating	● Willingness to pay ● Green consumption	Field experiment	● Italy ● 161 ● Shoppers	**Loss frame** (+) Loss frame → [anticipated shame →] WTP *Anticipated shame partially mediates the effect of the negative frame on donations; the effect of a positive frame is not stat. significant*
Amatulli et al., 2019 (Study 2)	● Goal framing ● Emotions (anticipated shame or guilt) - mediating	● Intention ● Green consumption	Online experiment	● n/a ● 146 ● MTurk	**Loss frame** (+) Loss frame →[anticipated shame] + higher environmental concern → intention *Higher environmental concern fully moderates both the direct effect of negative frame on intention and the mediating effect through anticipated shame.*
Amatulli et al., 2019 (Study 3)	● Goal framing ● Emotions (anticipated shame or guilt) - mediating ● Environmental concern (manipulated - salient / non-salient) - moderating	● Intention ● Green consumption	Online experiment	● n/a ● 126 ● MTurk	**Loss frame** (+) Loss frame→ [anticipated shame] + salient environmental concern {mod.} → intention *Salience of environmental concern fully moderates both the direct effect of negative frame on intention and the mediating effect through anticipated shame.*
Amatulli et al., 2019 (Study 4)	● Goal framing ● Emotions (anticipated shame or guilt) ● Product type (luxury or not) - moderating	● Willingness to pay ● Green consumption	Online experiment	● n/a ● 124 ● MTurk	**Loss frame** (+) Loss frame →anticipated shame + non-luxury product {mod.} → WTP *The interaction between anticipated shame and type of product (non-luxury) fully mediates the effect of negative frame on willingness to donate*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Arbuthnott and Scerbe, 2016	● Goal framing	● Attitude (concern, political support) ● Green consumption, transport use	Survey	● Canada ● 113 ● Students	**Loss frame** (+) Loss frame → concern, political support for environmental action *Loss (gain) framed messages led to higher (lower) support for policy change than baseline*
Avineri and Waygood, 2013	● Attribute framing ● Metric variation (scale of CO2)	● Beliefs ● Transport use	Online experiment	● United Kingdom ● 194 ● Adults	**Loss frame** (+) Loss frame + larger scale of CO2 compared {mod.} → beliefs *Metric variation partially moderated the positive effect of a loss framed message on beliefs about CO2 from each transport mode*
Baek and Yoon, 2017 (Study 1)	● Goal framing ● Emotions (induced shame or guilt) - moderating	● Intention ● Water efficiency (conservation)	Laboratory experiment	● United States ● 275 ● Students	**Loss and gain frame** (+) Loss frame + feeling of shame {mod.} → intention to save water (+) Gain frame + feeling of guilt {mod.} → intention to save water *Individually, no independent variable led to a greater intention to conserve water, but both interaction effects were stat. significant*
Baek and Yoon, 2017 (Study 2)	● Goal framing ● Emotions (induced shame or guilt)	● Intention ● Water efficiency (conservation)	Online experiment	● United States ● 234 ● Adults (MTurk)	**Loss and gain frame** (+) Loss frame + feeling of shame {mod.} →intention to save water (+) Gain frame + feeling of guilt {mod.} → intention to save water *Individually, no independent variable led to a greater intention to conserve water, but both interaction effects were stat. significant*
Baek and Yoon, 2017 (Study 3)	● Goal framing ● Emotions (induced shame or guilt) ● Commitment device (effort to pledge) - moderating	● Attitude ● Waste and recycling	Online experiment	● United States ● 150 ● Students	**Gain frame** (+) Loss frame + feeling of shame + high effort {mod.} → attitude (+) Gain frame + feeling of guilt + high effort {mod.} → attitude (+) Gain frame + feeling of shame/guilt + low effort {mod.}→ attitude *3-way interaction effects between message frame, induced emotion and commitment device for improved attitude towards recycling, but no main effects.*
Bilandzic et al., 2017	● Goal framing ● Emotions (guilt, fear, hope) - mediating	● Intention (willingness to sacrifice), attitude (perceived threat) ● Pollution and climate change	Survey	● Germany ● 247 ● Adults	**Loss frame** (+) Loss frame → feeling of guilt, feeling of fear → intention, attitude (+) Gain-negative frame ("wont' bad") --> intention, attitude Gain-positive frame ("will good") → (+) hope → (-) intention, attitude *A loss-framed message increased willingness to sacrifice, an effect mediated by feelings of guilt and fear; the effectiveness of a gain-framed message depended on whether it fit into the will-good or won't bad category.*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Blose et al., 2015	● Goal framing ● Proximity (of benefits - generic vs local)	● Intention ● Water efficiency (linen reuse)	Survey experiment	● United States ● 427 ● Hotel guests	**Loss frame** (+) Loss frame + generic destination {mod.} → intention to participate *Subjects in the generic destination condition were more willing to participate when presented with a loss frame; for local benefits of action, intention did not differ across frame type*
Bull, 2012	● Goal framing ● Metric variation (€ vs CO2, annual vs lifetime)	● Willingness to pay ● Energy efficiency (purchase of energy efficient washing machine)	Online experiment (stated preference survey)	● United Kingdom ● 465 ● n/a	**Loss frame** (+) Loss frame + information about running emissions → WTP *Together with information about the environmental impact of purchase, the loss frame led to higher willingness to pay; changes among participants presented with financial impact of purchase were not stat. significant*
Casado-Aranda et al., 2017	● Goal framing ● Message source (male vs female voice of messenger)	● Attitude (towards green ad) ● Green consumption	Laboratory experiment (fMRI)	● Spain ● 16 ● n/a	**Gain frame** (+) Gain frame → activation of anterior cingulate cortex → attitude *Gain frame led to a more positive attitude towards the green advert*
Chang et al., 2015 (Study 1)	● Goal framing ● Proximity (of impact - temporal) - moderating	● Intention (to purchase), atittude (toward ad) ● Green consumption (washing liquid)	Laboratory experiment	● United States ● 253 ● Students	**Loss frame** (+) Loss frame + proximal temporal construal {mod.} → intentions (+) Loss (gain) frame + proximal (distant) temporal construal {mod.} → attitude *Combined with proximal temporal construal, the loss frame had an effect on both attitudes and intentions; gain framing, when combined with distant temporal construal, had an effect on attitudes only.*
Chang et al., 2015 (Study 2)	● Goal framing ● Proximity (of impact - temporal) - moderating ● Level of environmental concern	● Intention (to purchase), atittude (toward ad) ● Green consumption (hybrid cars)	Laboratory experiment	● United States ● 157 ● Students	**Loss frame** (+) Loss frame + proximal temporal construal {mod.} → intentions (++) Loss (gain) frame + proximal (distant) temporal construal {mod.} + high environmental concern {mod.} → attitude *A loss-framed message combined with proximal temporal construal led to higher intention to buy a hybrid vehicle than a gain-framed message. The positive effect of loss (gain) framed messages together with a proximal (distant) temporal construal on attitudes was fully moderated by level of environmental concern.*
Craig, 2018	● Goal framing - mediating ● Experience (previous participation in energy efficiency programs)	● Attitude (policy support) ● Energy efficiency	Survey	● United States ● 1.159 ● Registered voters	**Loss frame** (+) Previous participation in energy efficiency programs → [loss frame →] policy support *The effect of previous participation in energy efficiency programmes on policy support was partially mediated by the loss-framed message*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Craig and Allen, 2014	● Goal framing	● Attitude (policy support) ● Energy efficiency	Survey	● United States ● 2.058 ● Registered voters	**Loss frame** (+) Loss frame → policy support *A loss frame led to higher support for energy efficiency subsidies than a gain frame, but no difference in support for cleaner energy sources*
Davis, 1995	● Goal framing ● Proximity (of impact - generation) ● Level of activity	● Intention ● Waste and recycling, green consumption, biodiversity and conservation	Survey	● United States ● 218 ● Students	**Loss frame** (+) Loss frame + current generation → intention (0) Activity framing → intention *No individual effect of the variables; 2-way interaction effect between loss frame and impact on current generation was most effective*
Dharshing et al., 2017 (Study 1)****	● Goal framing ● Political orientation - moderating	● Attitude (policy support) ● Energy efficiency	Choice experiment	● Switzerland ● 183 ● Homeowners	**Loss frame** (+) Loss frame + right-wing affiliation → political support *Political support for energy efficiency subsidies among right-wing voters was significantly higher when framed as tax rebates (loss)*
Faccioli et al., 2019	● Goal framing ● Level of uncertainty	● Willingness to pay ● Biodiversity and conservation	Choice experiment	● Spain ● 593 ● Natural park visitors	**Loss frame** (++) Loss frame + certainty → WTP (+) Gain frame + uncertainty → WTP *Loss-framed certain outcomes on biodiversity led to the highest WTP, followed by loss-framed uncertain outcomes and gain-framed uncertain outcomes.*
Feinberg and Willer, 2011 (Study 1)****	● Goal framing ● "Just world" beliefs - moderating	● Beliefs ● Pollution and climate change	Laboratory experiment	● United States ● 97 ● Students	**Gain frame** (-) Gain frame → scepticism about global warming (+) Loss frame + strong "just world" beliefs → scepticism *The gain frame led to reduced scepticism about global warming, as did the loss frame but only when combined with strong "just world" beliefs*
Grazzini et al., 2018 (Study 2)	● Goal framing ● Construal level - moderating ● Perceived (self-)efficacy - mediating	● Intention ● Waste and recycling	Laboratory experiment	● United Kingdom ● 145 ● Hotel guests	**Loss frame** (+) Loss frame + concrete information → self-efficacy → intentions *Perceived self-efficacy fully mediated the positive effect of loss frame combined with concrete information on intentions to recycle*
Holland et al., 2019	● Goal framing ● Experience (with water scarcity) ● Political orientation	● Intention, attitude, beliefs ● Water efficiency	Online experiment (stated preference survey)	● n/a ● 466 ● MTurk	**Gain frame** (+) Gain frame → attitude, beliefs (0) Frame → intention to conserve water *A gain-framed message led to higher concern and perceived message credibility but did not lead to a greater intention to conserve water*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Hu et al., 2018	● Goal framing ● Message source (motivation attribution - self-interest vs altruism)	● Intention ● Water efficiency (hotel linen laundering)	Survey experiment	● China ● 122 ● Hotel guests	**Loss frame** (+) Loss frame + altruistic motivation attribution {mod.} → intention *A loss framed message led to the greatest intention to reuse hotel linen, an effect partially moderated by altruistic motivation attribution*
Huang et al., 2019	● Goal framing ● Proximity (self vs other-reference) ● Use of visuals	● Intention ● Waste and recycling	Online experiment	● United States ● 562 ● MTurk	**Neither** Loss frame + other reference point + infographics {mod.} → (+) risk perception → (0) intention *A loss-frame combined with other reference point increased the perceived level of risk when the text was presented in the form of info graphics, but did not impact the self-other risk gap in perceived harm, which was the only factor that influenced intention to recycle*
Jain et al., 2019	● Attribute framing	● Emotional arousal ● Biodiversity and conservation	Laboratory experiment (ECG)	● United States ● 10 ● Students	**Neither** (0) Frame → heart rate *Neither the positive nor the negative frame had an effect on emotional arousal.*
Kim and Kim, 2014	● Goal framing ● Message source	● Attention, attitude, intention ● Energy efficiency, waste and recycling (reuse, reduction and recycling)	Online experiment	● United States ● 386 ● General	**Gain frame** (+) Gain frame + credible source {mod.}→ attention, attitude, intention *A gain-framed message led to more positive attention and attitude to the green message as well as behavioural intention, an effect that was stronger when the source was credible.*
Kragt and Bennett, 2012	● Goal framing ● Metric variation (absolute vs relative quantities)	● Willingness to pay ● Biodiversity and conservation	Choice experiment	● Australia ● 547 ● General	**Loss frame** (+) Loss frame → WTP *Respondents reported a higher WTP to prevent species lost (loss frame) than to maintain the number of species present (gain frame)*
Li et al., 2019	● Goal framing ● Metric variation (double entry mental accounting) ● Environmental values	● Willingness to pay ● Energy efficiency (green housing)	Survey	● China ● 2.137 ● Urban residents	**Loss frame** (+) Loss frame + egoistic values {med.} → WTP *Egoistic values partially mediated the positive impact of a loss-framed (subtractive) message on willingness to pay*
Lord, 1994 (Study on preferences)	● Goal framing ● Message source (advertising, publicity, personal)	● Beliefs, attitude ● Waste and recycling (curbside recycling)	Survey	● US ● 140 ● Households	**Gain frame** (+) Gain frame + any message source → attitude towards recycling *The positively framed messages led to greater belief in reasons for-, and an improved attitude towards recycling, an effect slightly moderated by the message source*
Loroz, 2007 (Study 1)****	● Goal framing ● Proximity (of impact - self vs other) - moderating	● Attitude ● Waste and recycling	Survey experiment	● United States ● 90 ● Students	**Loss frame** (+) Loss frame + self reference → attitude *The most effective appeals where negatively framed messages emphasising impact on the self*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Lu, 2016	● Goal framing - moderating ● Emotions (sadness, hope)	● Intention (behaviour itself and to seek information about it), attitude (policy support) ● Biodiversity and conservation	Online experiment	● United States ● 555 ● MTurk	**Loss and gain frame** (+) Gain frame + sadness → intention, policy support *A gain-framed message combined with a sadness appeal was the most effective in improving pro-environmental variables, but the least effective when combined with the hope appeal*
Maibach et al., 2010	● Goal framing	● Attitude towards statement ● Pollution and climate change	Interviews	● United States ● 69 ● Adults	**Gain frame** (+) Gain frame → perceived helpfulness of message *Respondents had a more positive attitude towards the information received when presented with mitigation-related policy actions than with threat statements*
Martinez-Fiestas et al., 2015	● Goal framing ● Attribute framing	● Attitude, emotional arousal ● Green consumption	Laboratory experiment (psycho-physiological methods)	● n/a ● 104 ● General	**Gain frame** (+) Gain frame →activation of appetitive motivation system → attitude *The positive/gain message led a positive attitude towards the advert.*
Mir et al., 2016	● Goal framing ● Proximity (of impact - geographical)	● Intention ● Transport use	Survey experiment	● Iran ● 213 ● Students	**Gain frame** (+) Gain frame → intention to use environmentally friendly transport *Framing positive impacts of mitigating air pollution was more effective in increasing intention to cycle or use the bus. Distance of impact had no effect on green behavioural intentions.*
Moon et al., 2016	● Goal framing	● Intention ● Transport use	Online experiment	● United States, Australia ● 784 ● Students, MTurk	**Loss frame** (+) Loss frame → intention to opt for blended fuel options *The loss-framed message led to a significantly higher increase in green behavioural intentions than a hybrid (gain and loss) framing, and higher increase than in the gain-framed condition but not significantly so.*
Morton et al., 2011 (Study 1)	● Goal framing ● Level of uncertainty	● Intention ● Waste and recycling, green consumption, transport use, pollution and climate change	Survey experiment	● n/a ● 88 ● Adults	**Gain frame** (+) Loss (gain) frame + low (any level) uncertainty → intention *A gain-framed message led to greater willingness to act, no matter the coupled level of uncertainty; a loss framed message was effective only when combined with low level of uncertainty*
Morton et al., 2011 (Study 2)	● Goal framing ● Level of uncertainty ● Perceived efficacy - mediating	● Intention ● Waste and recycling, green consumption, transport use, pollution and climate change	Survey experiment	● United Kingdom ● 120 ● Students	**Gain frame** (+) Gain frame + high uncertainty → [efficacy →] intention *A gain-framed message with high uncertainty was associated with the strongest green intentions, a connection partially mediated by efficacy*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Muralidharan and Sheehan, 2016	● Goal framing	● Intention ● Waste and recycling (use of reusable bags)	Online experiment	● United States ● 315 ● Shoppers	**Loss frame** (+) Loss frame → intention *The prospect of a tax led to greater green intentions than the possibility of avoiding a fee*
Nabi et al., 2018 (Study on preferences)	● Goal framing ● Emotion - mediating	● Attitude ● Pollution and climate change	Online experiment	● United States ● 337 ● Students	**Gain frame** (+) Gain frame → hope → attitude *Gain framed messages had a significant effect on improved green attitude, which was fully mediated by hope.*
Nilsson et al., 2014	● Goal framing ● Emotion - mediating	● Intention, emotions ● Energy efficiency (use of green electricity)	Survey	● Sweden ● 655 ● Adults	**Loss and gain frame** (+) Gain (loss) frame →[positive (negative) emotion →] intention *Emotion partially mediates the positive relationship between framing and intention to purchase eco-friendly electricity*
Obermiller, 1995 (Study 1)	● Goal framing ● Proximity (issue salience) ● Information ● Perceived efficacy ● Concern	● Intention, attitude ● Energy efficiency (conservation), water efficiency	Survey experiment	● n/a ● 95 ● Adults	**Loss and gain frame** (+) Loss (gain) frame + low (high) issue salience + additional information {mod.} → intention, attitude *Loss-framed messages were more effective when combined with low immediate relevance of environmental damage; the opposite holds for gain-framed messages. Both framings benefited from additional info*
Obermiller, 1995 (Study 2)	● Goal framing ● Proximity (issue salience) ● Information ● Perceived efficacy ● Concern	● Intention, attitude ● Waste and recycling (reduction and recycling)	Survey experiment	● n/a ● 205 ● Adults	**Gain frame** (+) Gain frame + high issue salience → intention, attitude *Only the combination of gain-framed messages with high issue salience had a statistically significant (although small) effect on attitude and intention to recycle, with no benefit of additional information*
Olsen et al., 2014	● Attribute framing ● Message source (credibility)	● Attitude (towards brand) ● Green consumption	Survey	● United States ● 38.000 ● General	**Neither** (0) Frame → brand attitude *The effect of a positive or negative frame on product labels did not have a statistically significant effect on brand attitude*
Park and Song, 2019	● Goal framing ● Self-construal (independent vs interdependent) - moderating ● Perceived personal relevance - mediating	● Intention, attitude ● Waste and recycling	Online experiment	● United States ● 108 ● Students	**Gain frame** (+) Promotion-focus (gain frame) + interdependent self-construal {mod.} → [issue involvement →] attitude, intention *For individuals with an interdependent self-construal a gain-framed message led to improved attitude and higher intention to recycle; the former effect was fully mediated and the latter partially mediated by greater issue involvement. A loss-framed message did not have a statistically significant effect.*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Patt and Zeckhauser, 2000	● Goal framing	● Attitude ● Pollution and climate change	Survey experiment	● United States ● 200 ● Students, shoppers	**Gain frame** (+) Gain frame → attitude *18 p.p. more respondents chose the environmental outcome formulated as a gain than the one in the form of loss prevention*
Spence and Pidgeon, 2010	● Goal framing ● Proximity (of impact - local vs distant) ● Emotions (fear responses) - mediating ● Information processing - mediating	● Attitude, beliefs ● Pollution and climate change	Online experiment	● United Kingdom ● 161 ● Students	**Gain frame** (+) Gain frame - information recall - fear → attitude, beliefs *A gain-framed message led to a higher perceived severity of impact of climate change and improved attitudes, though this was partially suppressed by weaker information recall and lower fear response*
Tu et al., 2013	● Attribute framing ● Information (green messaging)	● Attitude (towards brand), intention ● Green consumption	Laboratory experiment	● Taiwan ● 167 ● Students	**Positive frame** (+) Positive frame → attitude (0) Frame, green messaging --> purchase intention *Attitude towards the brand was better in the positive-frame message, but the frame didn't have an effect on purchase intention*
Vogdrup-Schmidt et al., 2019	● Goal framing ● Social norms (contribution of others)	● Willingness to pay ● Biodiversity and conservation	Choice experiment	● Denmark ● 1.618 ● Dutch and Danish residents	**Loss frame** (+) Loss frame → WTP for gains of habitat area *The willingness to pay was higher when participants were presented with a loss (to habitats) frame, though only when they were informed that only the local population contributed*
White et al., 2011 (Study 2)	● Goal framing ● Construal level - moderating	● Intention ● Waste and recycling	Laboratory experiment	● Canada ● 119 ● Students	**Loss and gain frame** (+) Loss (gain) frame + proximal (distant) temporal construal {Mod.} → intentions *A loss-framed appeal combined with a proximal temporal construal and a gain-framed appeal with a distant temporal construal both led to improved intentions to recycle of equal measure*
White et al., 2011 (Study 3)	● Goal framing ● Construal level - moderating ● Information processing - mediating ● Perceived (self-)efficacy - mediating	● Intention ● Waste and recycling	Laboratory experiment	● Canada ● 107 ● Students	**Loss and gain frame** (+) Loss (gain) frame + proximal (distant) temporal construal {Mod.} → processing fluency → efficacy → intentions *The effect of the interaction between frame and construal level type on intentions is fully mediated by processing fluency, whose effect on recycling intentions is in turn mediated by perceived self-efficacy*

(Table continues)

Appendix 3b: Systematic literature review empirical results: stated preferences *(cont.)*

Wilson et al., 2008	● Goal framing ● Attribution	● Attitude ● Biodiversity and conservation	Online experiment	● United States ● 204 ● Adults	**Neither** (+) Frame → perceived value *The value participants placed on losses versus gains to habitats did not differ significantly.*
Wolske et al., 2018	● Goal framing ● Proximity (temporal) ● Metric variation	● Intention, attitude ● Energy efficiency	Online experiment	● United States ● 2.055 ● Homeowners	**Neither** (0) Frame → intention / attitude *The frame type did not influence participants' attitude towards solar energy or intention to invest in solar photovoltaics*

Note: (+) positive effect, (-) negative effect, (0) no statistically significant effect. {Mod.} = moderating variable

Appendix 4: Screening survey text

Welcome,

You are about to participate in a short scientific study on air travel frequency in light of the Covid-19 pandemic and accompanying travel restrictions.

The survey will take approximately **1 minute** of your time. It only has a few questions, but please answer those earnestly.

The **benefits** from participating are a reward of £0.10 and the knowledge that you helped with scientific research. There are no foreseen risks from participating. Participation is voluntary and you can withdraw at any time without justification.

The study will only collect anonymised data, which will be used and processed exclusively by the research team for research purposes. The study follows strict data protection and privacy standards and complies with the General Data Protection Regulation of the EU (GDPR).

For any questions, feel free to contact the main researcher, Aja Ropret Homar, at aja.ropret.homar@ef.uni-lj.si.

Do you consent to participate in the study?

○ Yes, I consent to participate in the study

○ No, I do not consent to participate in the study

if 'yes' → please enter your Prolific participant ID: _____

1. Please indicate the last time…

   a. You went on holiday [drop down menu year]

   b. You travelled abroad for leisure [drop down menu year]

   c. You travelled abroad for business [drop down menu year]

   d. You took a flight for leisure purposes [drop down menu year]

   e. You took a flight for business purposes [drop down menu year]

2a) (if 1.d =/= never) When was the last time you booked the leisure flight yourself
[drop down menu year]

OR

2b) (if 1.e =/= never) When was the last time you booked the business flight yourself
[drop down menu year]

OR

2c) (if 1.d AND 1.e =/= never) When was the last time you booked the flight**s** yourself

Leisure [drop down menu year]

Business [drop down menu year]

Please indicate your gender:

○ Female

○ Male

○ Other

○ Prefer not to disclose

Please indicate your age:

Please indicate your income range:

[drop down menu]

Appendix 5: Online experiment text

Welcome,

You are about to participate in a scientific study of people's awareness and knowledge of voluntary carbon offsets. Thank you for your interest!

The survey will take approximately **7-12 minutes**, depending on your choices. You will be awarded **£1.00** for your time.

If you decide to participate, we kindly ask you to take this study seriously, to respond honestly and to the best of your abilities. There will be a few attention checks throughout the survey and please be aware that if you fail to answer them correctly, your submission may be rejected and we cannot reward you.

Below you will find details about the study to help you decide whether you consent to participate.

What is the research about?

We are conducting research on voluntary carbon offsets (VCOs) - a compensation scheme for emitted carbon dioxide: by purchasing a so-called voluntary carbon offset for an activity (say, flight) that are sold by a number of environmental non-governmental organisations, an individual can help reduce carbon dioxide emitted elsewhere. We as researchers are interested in your awareness, knowledge and opinion of these schemes. You are not required to have any prior knowledge of carbon offsets in order to participate in the study.

What does my participation involve?

You will be first asked to read a description of voluntary carbon offsets; this will be followed by an optional task and some survey questions. The survey itself will take approximately 6 minutes to complete.

What are the risks and benefits?

The benefits from participating are a reward of £1.00 and the knowledge that you helped with scientific research.

There are no foreseen risks from participating. Participation is voluntary and you can withdraw at any time without justification.

How will my data be used?

We only collect anonymized data, which means that there are no answers in the survey with which we or anyone else could identify you.

All data collected through this survey will be processed and used exclusively for academic research. The data may be presented and published in aggregate and anonymous form in academic journals, reports or books.

The study follows strict data protection and privacy standards and complies with the General Data Protection Regulation of the EU (GDPR). It has been approved by the Ethics Committee from the School of Economics and Business of the University of Ljubljana.

Who can I contact in case of questions or complaints?

For any survey-related questions, feel free to contact the main researcher, Aja Ropret Homar, at aja.ropret.homar@ef.uni-lj.si.

For any questions on your data protection rights, please turn to the authorized person for the protection of personal data at the University of Ljubljana School of Economics and Business, Jure Jeklič (jure.jeklic@ef.uni-lj.si).

By consenting to participate in the study you confirm that you have read, understood and agree with the information presented above.

○ I consent to participate in the study

○ I do not consent to participate in the study

- - - - - page break - - - -

Please enter your Prolific participant ID: _____

- - - - - page break - - - -

Please read the following information, which you will need for answering the survey questions.

A **voluntary carbon offset** (VCO) is a way for individuals and organisations to reduce their carbon footprint.

A carbon offset is an environmental benefit from an initiative that avoids or reduces greenhouse gas pollution from the environment. These initiatives include enabling the shift to renewable energy, improving energy efficiency of domestic appliances, and funding reforestation, all typically in developing countries. Carbon offsetting schemes are provided by a number of non-governmental organisations and other entities, and are verified by third-party certification programs.

A voluntary carbon offset is a payment from the individual or organisation towards these schemes in order to **compensate for carbon dioxide emissions from their activity**. One commonly offset activity is air travel, since this is the single highest one-off emitter of global greenhouse gasses in an individual's annual carbon footprint. The schemes enable the compensation of past flights, providing a calculation of emitted CO_2 for a precise flight route.

Airline companies also often provide passengers with the opportunity to purchase a VCO for their flight at the point of booking.

For reference, one passenger on a flight from London to Paris generates around 0.1 tonne of emitted CO_2, which costs £1-£5 to offset; on a transatlantic flight from London to New York, they generate cc. 1 tonne of CO2, costing between £5-£30 to offset, depending on the provider, and the location and type of project chosen.

[Control group:] /

OR

[Gain frame treatment group:] **Therefore, by purchasing a voluntary carbon offset for a flight, we can contribute to reducing the net climate change impacts of air travel, and with this to a cleaner and healthier environment.**

OR

[Loss frame treatment group:] **Therefore, by taking a flight without purchasing a voluntary carbon offset, we may be contributing to higher net carbon emissions and with this to a more polluted and unhealthy environment.**

[Attention checks:] To confirm you have read the text, please answer the following questions:

What types of projects can voluntary carbon offsets help fund, according to the text?

○ Increasing enrolment in primary school among girls

○ Purchase of more energy efficient domestic appliances

○ Purchase of malaria nets

○ Post-earthquake humanitarian relief

[Gain frame treatment group:] What is the expected outcome of purchasing voluntary carbon offsets for flights on the environment?

○ Cleaner environment ○ more polluted environment

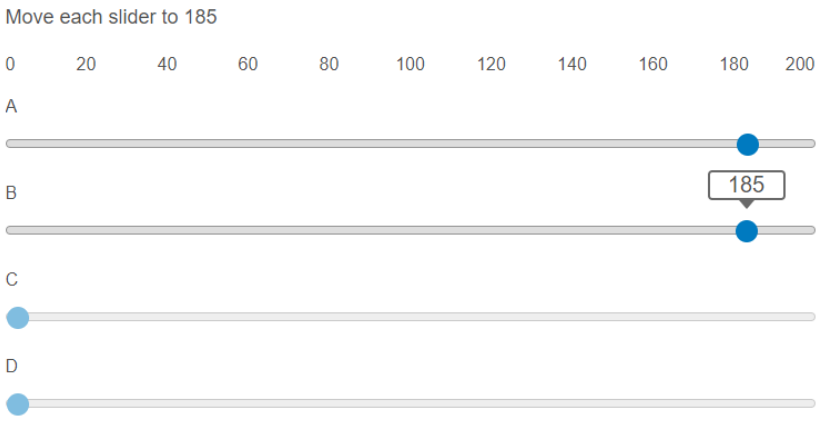
[Loss frame treatment group:] What is the expected outcome of taking flights without purchasing voluntary carbon offsets on the environment?

○ Cleaner environment ○ more polluted environment

- - - - - page break - - - -

On the next page is an **optional slider task**. By doing the task you can earn up to £1.00 to purchase a voluntary carbon offset. If you choose this option, you will be given a menu of voluntary carbon offset providers, from which you can choose one to allocate your earnings to. Please note that this is not hypothetical; we will allocate your earnings from the task to the VCO provider you select (your original participation reward is yours to keep). Also note that we as scientists have no commercial relation to any carbon offset provider and are happy to provide you with receipts of purchase after the study has been complete, if you so wish (the main researcher's contact is aja.ropret.homar@ef.uni-lj.si).

TASK DESCRIPTION**:** The task is to move a slider to a random targeted number between 0 and 200, as illustrated below. For each set of four sliders you will earn £0.10. This should take up to 5 minutes to complete in full, but you can end the task at any time. Your contribution will be calculated based on the number of sliders you completed.



If you choose to do the task, you will be taken to more detailed instructions, followed by the exercise. After you are finished, you will continue onto the final sections of the survey, which should take a further 5 minutes.

If you choose not to do the task, you will proceed with the final sections of the survey, which should take about 5 minutes.

Would you like to do the task?

○ Yes, take me to the task

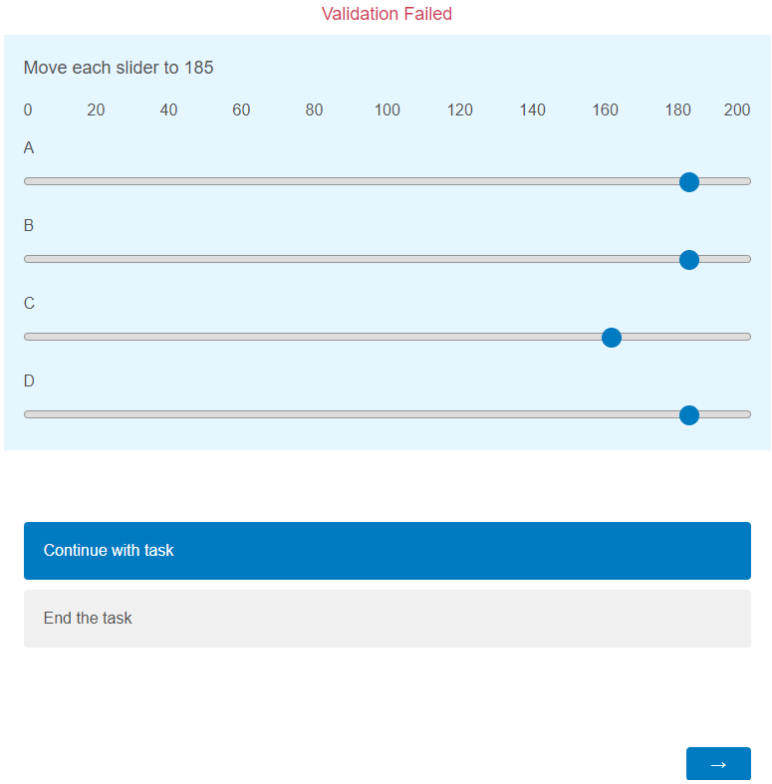
○ No, skip the task → recipient is taken to the survey questions

- - - - - -

TASK (Q I)

Your task will be to move a slider to the specified value. The slider in control has the number it is currently placed at display above, as illustrated in B below. This way, you will know when the slider is at the correct value.

Once you are done, click “validate and continue with task” to move onto the slider set. You will only be able to proceed if all sliders are correctly placed; if one or more sliders is not at the correct value, an error message will appear.



There are 10 sets of 4 sliders to complete in total. Completing the entire exercise should take about 5 minutes.

You can choose to end the task at any time. In this case, select the “end the task” button. This will take you to the list of voluntary carbon offset providers, and you will then continue the survey as normally. You will not be penalized for ending the task in this way. Your

contribution will be calculated based on the number of slider sets you did complete, with each slider set yielding £0.10.

Please click next when you are comfortable that you have understood the instructions.

[Task continues with 10 sets of 4 sliders]

- - - - - -

As a reminder, a voluntary carbon offset is a payment towards initiatives that avoid or reduce greenhouse gas pollution from the environment. It is made in order to compensate for carbon dioxide emissions from an individual's own activity, such as air travel.

[Control group:] /

[Gain] By purchasing a voluntary carbon offset for a flight, we can contribute to reducing the net climate change impacts of air travel, and with this to a cleaner and healthier environment.

[Loss] By taking a flight without purchasing a voluntary carbon offset, we may be contributing to higher net carbon emissions and with this to a more polluted and unhealthy environment.

II. Your earned £ How would you like to use your additional earnings?

○ **I would like to collect them** (this will increase your total reward for participating by the amount you earned in the task)

○ **I would like the amount I indicated to be paid to the following (third party certified) carbon offset provider:**

- ○ Atmosfair
- ○ myclimate
- ○ Native Energy
- ○ Terrapass
- ○ I don't mind

- - - - page break - - - -

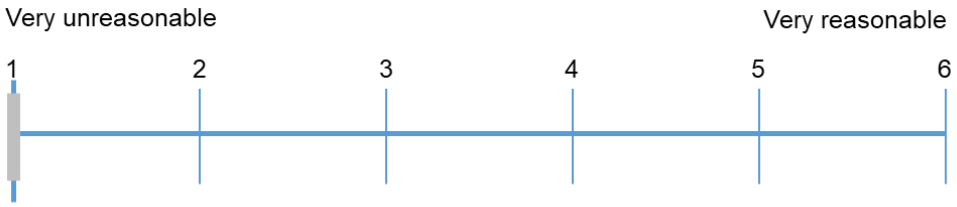
II. Prior to this survey, how familiar were you with voluntary carbon offsets (VCOs)?

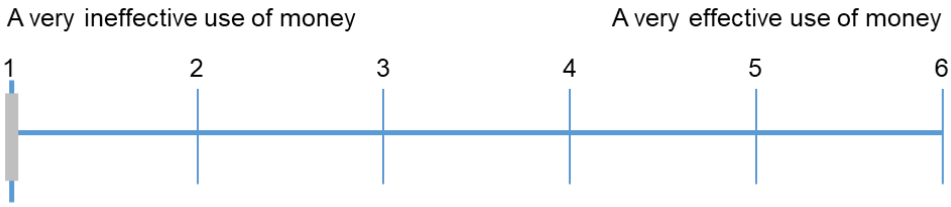
- ○ Not at all familiar - I have never before heard of VCOs
- ○ Barely familiar - I have heard of VCOs but did not know anything about them
- ○ Somewhat familiar – I had limited knowledge of VCOs

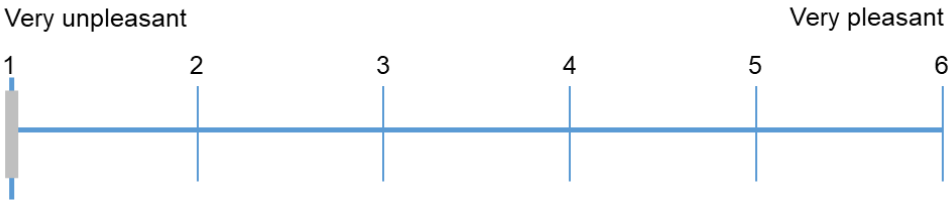
○ Familiar – I had good knowledge of VCOs
○ Very familiar – I had extensive knowledge about VCOs, including its benefits, different programs available and prevalence

III. Have you ever purchased a voluntary carbon offset (prior to this survey)?
○ No
○ Yes – for a flight
○ Yes – for a different activity

IV. Please indicate: "for me to pay for voluntary offsets of my flights would be:"







V. Please indicate to what extent you agree or disagree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
If I take a flight, my actions contribute to climate change.	○	○	○	○	○	○
Voluntary carbon offsets will reduce carbon emissions elsewhere through VCO projects	○	○	○	○	○	○

Projects funded through VCOs will positively impact the environment	○	○	○	○	○	○
It is mostly up to me whether or not I pay for voluntary offsets of my flights.	○	○	○	○	○	○
Please select that you strongly disagree here	○	○	○	○	○	○
Most people who are important to me would think that I should pay for VCOs	○	○	○	○	○	○
Most people who are close to me would themselves pay for VCOs for their flights.	○	○	○	○	○	○
I intend to pay for voluntary offsets of a flight I took	○	○	○	○	○	○

- - - - - page break - - - -

VIa. (Appears if respondent chose to purchase a VCO)

Please indicate why you decided to engage the task and use your earnings to purchase a voluntary carbon offset (select at most 3 strongest reasons):

□ It is the right thing to do

□ It ensures the CO_2 my flight produced is reduced through another means

□ It makes me feel good to give money to environmental causes

□ I would feel guilty if I hadn't purchased a VCO

□ I would feel ashamed that I hadn't if somebody asked me

□ I can feel proud telling I did so to my friends

□ It is not my money so it was easier to give away

□ I do not know

□ Other: _____

VIb. (Appears if respondent chose to take home their earnings)

Please indicate why you decided to not use your additional earnings to purchase a voluntary carbon offset (select at most 3 strongest reasons):

□ I earned the money myself

□ I do not trust the organisations that provide voluntary carbon offsets

□ I do not believe offsetting carbon is necessary

□ I do not believe the projects funded through voluntary carbon offsets have the stated or desired effect

□ I believe it is airlines - not individual passengers – who are responsible for CO2 emitted from flights

□ I donate to environmental causes through other means I am

□I behave environmentally-friendly in other ways

□ Other: _____

VIc. (Appears if respondent chose not to do the task)

Please indicate why you decided not to participate in the task to earn money to purchase a voluntary carbon offset (select at most 3 strongest reasons):

□ I do not have the time

□ It is not worth the effort

□ I do not trust the organisations that provide voluntary carbon offsets

□ I do not believe offsetting carbon is necessary

□ I do not believe the projects funded through voluntary carbon offsets have the stated or desired effect

□ I believe it is airlines - not individual passengers – who are responsible for CO2 emitted from flights

□ I donate to environmental causes through other means I am

□ I behave environmentally-friendly in other ways

□ Other: _____

- - - - page break - - - -

VI. How important are the following values to you:

	Opposed to my values	0 Not impor-tant	1	2	3 Impor-tant	4	5	6 Very impo-rtant	7 Of supreme impor-tance
Authority	○	○	○	○	○	○	○	○	○
Social power	○	○	○	○	○	○	○	○	○
Wealth	○	○	○	○	○	○	○	○	○
Influence	○	○	○	○	○	○	○	○	○
Social justice	○	○	○	○	○	○	○	○	○
Helpfulness	○	○	○	○	○	○	○	○	○
Equality	○	○	○	○	○	○	○	○	○
A world at peace		○	○	○	○	○	○	○	○
Protecting the environment			○	○	○	○	○	○	○
Preventing pollution		○	○	○	○	○	○	○	○
Respecting the earth		○	○	○	○	○	○	○	○
Unity with nature		○	○	○	○	○	○	○	○

VII. To what extent do the following apply?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I consider myself an eco-friendly person					
I would be willing to pay higher **prices** so industry could better protect the environment					
I would be willing to pay higher **taxes** to the government to improve environmental protection					
I am involved in the environmental movement					
I would accept more unemployment if needed to better protect the environment					
I engage in green lifestyle behaviours on a daily basis					
I donate to environmental causes					

VIII. On a typical (pre Covid-19) year, how frequently do you book and take a flight for leisure purposes (please count a return flight as 1 flight):

Never	Every few years	1-2x annually	3-5x annually	More than 5x
○	○	○	○	○

IX. Were any of your flights cancelled due to the measures accompanying Covid-19?

○ Yes ○ No

- - - - page break - - - -

Before you go, please do not forget to answer the following questions:

X. Please indicate your gender

○ Male ○ Female ○ Other ○ Prefer not to disclose

XI. Please indicate your age

_____

XII. Please provide an estimate of your gross monthly income

○ 0 - £999
○ £1,000 - £1,999
○ £2,000 - £2,999
○ £3,000 - £3,999
○ £4,000 - £4,999
○ £5,000 - £5,999
○ £6,000 - £6,999
○ £7,000 - £7,999
○ £8,000 - £8,999
○ £9,000 - £9,999
○ £10,000 or above
○ Prefer not to disclose

XIII. Please indicate your political orientation

○ Left-leaning ○ Centre ○ Right-leaning ○ Prefer not to disclose

XIV. What is the highest degree or level of education you have completed?

○ Primary school or less
○ High school or equivalent
○ Undergraduate / Bachelor's degree
○ Master's degree
○ Doctoral degree
○ Prefer not to disclose

XV. What is your current employment status?

- ○ Employed full time
- ○ Employed part time
- ○ Self-employed
- ○ Unemployed looking for work
- ○ Unemployed not looking for work
- ○ Student
- ○ Retired
- ○ Disabled
- ○ Prefer not to disclose

XVI. How many children do you have?
[Drop down-menu]

- - - - - - - - - - Thank you. You have reached the end of the survey. - - - - - - - - - -

Appendix 6: Pairwise comparison of attitudes – comparison of means

Socio-demographic characteristics: Mean attitude (1-6)			
Gender	female	(A)	3.83 B
	male	(B)	3.47
	other	(C)	3.17
Age_Range	18-24	(A)	3.49
	25-34	(B)	3.76
	35-44	(C)	3.70
	45-54	(D)	3.58
	55-64	(E)	3.70
	65 or above	(F)	3.81
	N/A	(G)	3.67
Income level (grouped)	500	(A)	3.94
	1500	(B)	3.67
	2500	(C)	3.69
	4000	(D)	3.64
	6500	(E)	3.88
	10500	(F)	3.00
Kids	0	(A)	3.62
	1	(B)	3.82
	2	(C)	3.65
	3	(D)	3.57
	4	(E)	4.00
Political orientation	Center	(A)	3.62
	Left	(B)	3.81
	N/A	(C)	3.67
	Right	(D)	3.47
Education	High school or less	(A)	3.68
	Master's or doctoral degree	(B)	3.52
	N/A	(C)	3.33[1]
	Undergraduate or professional degree	(D)	3.74
Employment	Full time	(A)	3.64
	Other	(B)	3.52
	Part time	(C)	4.10 A
	Self-employed	(D)	3.51
	Unemployed	(E)	3.84

Table continues

Appendix 6: Pairwise comparison of attitudes – comparison of means *(cont.)*

Psychographic characteristics: Mean attitude (1-6)			
Past purchase	No	(A)	3.61
	Yes	(B)	4.22 A
Biospheric value orientation	Bottom 75%	(A)	3.51
	Top 25%	(B)	4.18 A
Egoistic value orientation	Bottom 75%	(A)	3.66
	Top 25%	(B)	3.76
Altruistic value orientation	Bottom 75%	(A)	3.59
	Top 25%	(B)	3.95 A
Beliefs (trust in VCOs, personal responsibility and output efficacy)	Less than 3 of 6 'Sceptics'	(A)	3.74 B
	More than 3 of 6	(B)	1.92
Frequent fliers	Less than 3 flights annually	(A)	3.69
	More than 3 flights annually	(B)	3.60
Donation to environmental causes in the past	No	(A)	3.53
	Yes 'Benevolents'	(B)	3.89 A
Involvement in environmental movement	No	(A)	3.60
	Yes 'Environmental activists'	(B)	3.94 A

Appendix 7: Multivariate linear regression on attitude: full model

	Coef.	Std. Err	t	P>|t|	95% Conf.	
Constant	-0.126	0.368	-0.34	0.732	-0.849	0.597
Treatment (base=control)						
Gain	-0.038	0.098	-0.39	0.697	-0.230	0.154
Loss	0.016	0.097	0.16	0.871	-0.176	0.207
Personal responsibility	0.046	0.046	0.99	0.321	-0.045	0.137
Beliefs	0.276	0.049	5.58**	0.000	0.179	0.373
Self-efficacy	0.042	0.034	1.23	0.220	-0.025	0.109
Subjective norms	0.283	0.040	7.03**	0.000	0.204	0.363
Egoistic value orient.	-0.014	0.030	-0.46	0.647	-0.073	0.046
Altruistic value orient.	0.065	0.035	1.85	0.065	-0.004	0.133
Biospheric value orient.	0.012	0.040	0.29	0.771	-0.067	0.090
Green lifestyle	-0.107	0.064	-1.67	0.095	-0.233	0.019
Member of movement	0.036	0.044	0.81	0.416	-0.051	0.123
Past donation	-0.020	0.038	-0.53	0.594	-0.095	0.055
Env-econ trade-off	0.272	0.049	5.50**	0.000	0.175	0.370
Familiarity with VCOs	0.037	0.053	0.70	0.486	-0.068	0.142
Past purchase of VCOs	0.204	0.105	1.95	0.052	-0.002	0.410
Frequency of flying	-0.008	0.057	-0.15	0.883	-0.121	0.104
Covid-19 impact	0.050	0.089	0.57	0.572	-0.124	0.225
Gender (male)	-0.201	0.087	-2.32*	0.021	-0.371	-0.030
Age	0.004	0.004	1.04	0.297	-0.004	0.013
Inc	0.000	0.000	-1.40	0.161	0.000	0.000
Kids	-0.022	0.042	-0.54	0.592	-0.104	0.059
Political orientation (base=center)						
Left	-0.014	0.097	-0.15	0.881	-0.205	0.176
Right	-0.003	0.123	-0.03	0.979	-0.245	0.239
Education level (base=high school or less)						
Undergraduate or professional degree	0.064	0.095	0.67	0.501	-0.123	0.252
Master's or doctoral degree	-0.171	0.124	-1.38	0.168	-0.414	0.072
Employment status (base=full time)						
Part time employed	0.235	0.127	1.85	0.065	-0.014	0.484
Self-employed	-0.108	0.137	-0.79	0.431	-0.378	0.162
Unemployed	-0.014	0.183	-0.08	0.938	-0.373	0.345
Other	-0.130	0.129	-1.01	0.315	-0.384	0.124
Summary statistics						
Sample size	465					
R-squared	0.510					
Adjusted R-squared	0.474					
Root MSE	0.831					

** Significant at p < 0.05, ** significant at p < 0.01.*

Appendix 8: Logistic regression of treatment on attitude – coefficients

	Coef.	Std. Err	z	P>|z|	95% Conf.	
Constant	-8.540	1.166	-7.32	0.000	-10.825	-6.254
Treatment (base=control)						
Gain	-0.222	0.296	-0.75	0.452	-0.803	0.358
Loss	-0.027	0.295	-0.09	0.927	-0.604	0.550
Personal responsibility	-0.073	0.147	-0.49	0.622	-0.362	0.216
Beliefs2	0.645	0.155	4.17	0.000	0.342	0.949
Self-efficacy	0.175	0.108	1.62	0.106	-0.037	0.388
Subjective norms	0.650	0.126	5.17	0.000	0.403	0.896
Egoistic value orient.	0.125	0.090	1.39	0.163	-0.051	0.300
Altruistic value orient.	0.237	0.106	2.24	0.025	0.030	0.444
Biospheric value orient.	-0.117	0.118	-0.99	0.323	-0.349	0.115
Green lifestlye	-0.277	0.190	-1.46	0.145	-0.649	0.095
Env-econ trade-off	0.712	0.148	4.80	0.000	0.421	1.002
Past purchase of VCOs	1.177	0.367	3.21	0.001	0.458	1.896
Gender (male)	-0.325	0.255	-1.28	0.201	-0.825	0.174
Employment status (base=full time)						
Part time employed	0.503	0.388	1.30	0.195	-0.258	1.265
Self-employed	-0.236	0.413	-0.57	0.568	-1.046	0.574
Unemployed	0.089	0.520	0.17	0.865	-0.930	1.107
Other	-0.135	0.383	-0.35	0.725	-0.886	0.616
Summary statistics						
Sample size	465					
LL	-218.398					
LR Chi2 (18)	199.270					
Prob>chi2	0.000					
Pseudo R2 (McFadden)	0.313					
Akaike IC	474.796					

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Appendix 9: Univariate logistic regression of treatment on behaviour, split by survey order – coefficients

	Model A.1: beh-att dataset				Model A.2: att-beh dataset			
	Coef.	**z**	**P>|z|**	**Odds ratio**	**Coef.**	**z**	**P>|z|**	**Odds ratio**
Constant	-0.600	-2.55	0.011	0.549	-0.265	-1.14	0.253	0.767
Treatment								
Gain	0.089	0.27	0.788	1.093	-0.680*	-1.96	0.049	0.507
Loss	0.651*	1.99	0.046	1.917	-0.351	-1.06	0.291	0.704
Summary statistics								
Observations				237				228
LR chi2 ( )			(2)	4.77			(2)	3.94
Prob > chi2				0.092				0.139
McFadden pseudo R square				0.015				0.013
Cox & Snell R Square				0.027				0.02
Akaike IC				322.7				298.8
Bayesian IC				333.1				309.0

** Significant at p < 0.05, ** significant at p < 0.01.*

Source: author's own

Appendix 10: Multivariate logistic regression on behaviour result table

	Model 2A: full sample			Model 2B: full sample with interaction effects			Model 2C: beh-att order subsample			Model 2D: att-beh order subsample		
	Coef.	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**
Constant	-4.004	1.051	-3.81	-4.168	1.085	-3.84	-5.901	1.792	-3.29	-3.340	1.560	-2.14
Treatment (base=control)												
Gain	-0.333	0.273	-1.22	0.057	0.373	0.15	0.222	0.409	0.54	-0.902	0.438	-2.06*
Loss	0.163	0.261	0.63	0.790	0.370	2.14*	1.001	0.406	2.47*	-0.350	0.411	-0.85
Survey order (base=beh-att)												
Att-beh				0.351	0.372	0.94						
Treatment*surveyorder (base=control*att-beh)												
Gain*att-beh				-0.806	0.544	-1.48						
Loss*att-beh				-1.279	0.531	-2.41*						
Attitude	0.306	0.133	2.30*	0.326	0.135	2.41*	0.324	0.210	1.54	0.426	0.210	2.03*
Personal responsibility	-0.067	0.131	-0.51	-0.063	0.133	-0.47	-0.293	0.201	-1.46	0.114	0.207	0.55
Beliefs	0.304	0.144	2.11	0.292	0.145	2.01*	0.415	0.221	1.87	0.271	0.223	1.21
Self efficacy	-0.052	0.093	-0.56	-0.060	0.094	-0.63	-0.161	0.152	-1.06	-0.001	0.143	-0.01
Subjective norms	-0.160	0.117	-1.37	-0.134	0.119	-1.12	-0.343	0.186	-1.84	-0.222	0.193	-1.15
Egoistic value orient.	-0.080	0.084	-0.96	-0.074	0.085	-0.88	-0.181	0.130	-1.39	-0.029	0.138	-0.21
Altruistic value orient.	-0.113	0.096	-1.17	-0.143	0.098	-1.45	-0.169	0.139	-1.22	-0.184	0.170	-1.08
Biospheric value orient.	0.193	0.110	1.75	0.205	0.112	1.83	0.298	0.165	1.81	0.150	0.178	0.84
Green lifestlye	0.034	0.179	0.19	0.006	0.181	0.03	-0.074	0.270	-0.27	0.155	0.287	0.54
Involvement in movement	0.025	0.121	0.20	0.031	0.123	0.25	0.108	0.178	0.61	-0.158	0.201	-0.79
Past donation	-0.377	0.109	-3.45**	-0.383	0.110	-3.47**	-0.422	0.152	-2.79**	-0.354	0.187	-1.90
Env-econ trade-off	0.480	0.142	3.37**	0.492	0.145	3.40**	0.938	0.228	4.12**	0.319	0.233	1.37
Familiarity with VCOs	-0.116	0.148	-0.78	-0.092	0.150	-0.61	0.286	0.227	1.26	-0.415	0.241	-1.72
Past purchase of VCOs	0.264	0.274	0.96	0.241	0.278	0.87	0.562	0.437	1.28	0.267	0.478	0.56
Frequency of flying	0.195	0.156	1.25	0.216	0.157	1.37	0.245	0.239	1.02	0.311	0.252	1.23
Covid-19 impact	-0.466	0.244	-1.91	-0.504	0.248	-2.03*	-0.921	0.383	-2.41	-0.428	0.386	-1.11
Gender (male)	-0.212	0.236	-0.90	-0.246	0.239	-1.03	-0.238	0.365	-0.65	-0.317	0.379	-0.84

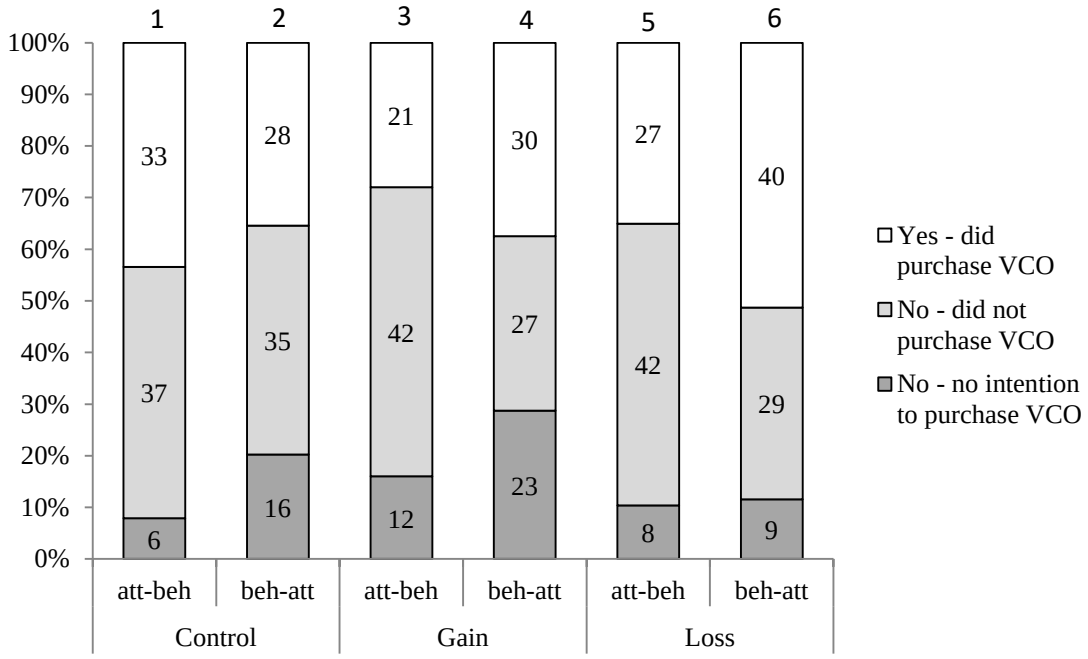
(Table continues)

Appendix 10: Multivariate logistic regression on behaviour result table *(cont.)*

	Model 2A: full sample			Model 2B: full sample with interaction effects			Model 2C: beh-att order subsample			Model 2D: att-beh order subsample		
	Coef.	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**	**Coef.**	**Std. Err**	**z**
Age	0.014	0.011	1.22	0.015	0.012	1.33	0.039	0.017	2.26	-0.005	0.018	-0.30
Income	0.000	0.000	1.17	0.000	0.000	1.02	0.000	0.000	2.23*	0.000	0.000	-0.51
Kids	0.056	0.112	0.50	0.048	0.115	0.42	-0.083	0.175	-0.47	0.260	0.188	1.38
Political orientation (base=center)												
Left	0.226	0.258	0.88	0.183	0.261	0.70	-0.832	0.411	-2.02*	1.052	0.409	2.57*
Right	-0.479	0.350	-1.37	-0.558	0.356	-1.57	-0.770	0.532	-1.45	-0.403	0.598	-0.67
Education level (base=high school or less)												
Undergraduate or professional degree	-0.039	0.263	-0.15	-0.063	0.266	-0.24	-0.057	0.398	-0.14	0.100	0.413	0.24
Master's or doctoral degree	0.369	0.337	1.10	0.319	0.340	0.94	0.223	0.514	0.43	0.640	0.528	1.21
Employment status (base=full time)												
Part time employed	0.552	0.338	1.63	0.593	0.343	1.73	1.160	0.593	1.96	0.463	0.508	0.91
Self-employed	0.311	0.372	0.84	0.288	0.380	0.76	0.331	0.534	0.62	0.948	0.660	1.43
Unemployed	-0.694	0.536	-1.29	-0.645	0.539	-1.20	-0.310	0.760	-0.41	-1.058	0.880	-1.20
Other	-0.139	0.359	-0.39	-0.137	0.365	-0.38	0.486	0.558	0.87	-0.579	0.611	-0.95
Summary statistics												
Sample size	465			465			236.000			228.000		
LL	-277.307			-272.931			-122.439			-120.540		
Prob > chi2	0.000			0.000			0.000			0.006		
Pseudo R square	0.105			0.119			0.236			0.187		
Akaike IC	582.614			579.862			308.878			307.079		

** Significant at p < 0.05, ** significant at p < 0.01.*

Appendix 11: Behaviour decision and survey order, per treatment



Source: author's own

Appendix 12: Multivariate linear regression on response times

	Coef.	Std. Err	t	P>|t|	95% Conf.	
Constant	-2.992	0.819	-3.65	0.000	-4.597	-1.387
Time	-0.005	0.004	-1.12	0.264	-0.013	0.004
Treatment*time						
Gain	0.000	0.007	0.04	0.970	-0.013	0.014
Loss	0.005	0.005	0.88	0.378	-0.006	0.016
Treatment						
Gain	0.138	0.610	0.23	0.821	-1.058	1.333
Loss	0.411	0.556	0.74	0.459	-0.678	1.500
Survey order: att-beh	0.403	0.362	1.11	0.265	-0.306	1.113
Treatment*surveyorder						
Gain*att-beh	-0.779	0.522	-1.49	0.136	-1.802	0.245
Loss*att-beh	-1.282	0.515	-2.49*	0.013	-2.290	-0.273
Attitude	0.310	0.127	2.45*	0.014	0.062	0.558
Personal responsibility	-0.029	0.127	-0.23	0.818	-0.279	0.220
Beliefs	0.218	0.138	1.58	0.114	-0.052	0.488
Subjective norms	-0.076	0.112	-0.68	0.496	-0.296	0.144
Egoistic value orient.	-0.148	0.076	-1.94	0.052	-0.298	0.001
Altruistic value orient.	-0.074	0.090	-0.82	0.414	-0.250	0.103
Biospheric value orient.	0.217	0.105	2.06*	0.040	0.010	0.423
Green lifestlye	-0.010	0.173	-0.06	0.956	-0.349	0.329
Member of movement	-0.033	0.109	-0.31	0.760	-0.248	0.181
Past donation	-0.306	0.103	-2.97**	0.003	-0.508	-0.104
Env-econ trade-off	0.453	0.135	3.35**	0.001	0.188	0.718

***** *Significant at p < 0.05, ** significant at p < 0.01.*

Appendix 13a: Multivariate logistic regression on attitude-behaviour gap dummy

	Coef.	Std. Err.	z	P>|z|	95% conf.	Interval
Constant	-1.152	0.984	-1.17	0.242	-3.080	0.776
Treatment (base=control)						
Gain	-0.229	0.345	-0.66	0.507	-0.905	0.448
Loss	-0.360	0.352	-1.02	0.306	-1.050	0.329
Survey order (base=beh-att)						
Att-beh	0.055	0.351	0.16	0.875	-0.632	0.743
Treatment*surveyorder (base=control*att-beh)						
Gain*att-beh	-0.526	0.507	-1.04	0.300	-1.521	0.469
Loss*att-beh	1.100	0.505	2.18	0.029	0.111	2.090
Personal responsibility	0.151	0.122	1.24	0.216	-0.088	0.390
Beliefs	0.115	0.131	0.87	0.382	-0.143	0.372
Self efficacy	-0.062	0.090	-0.69	0.488	-0.238	0.114
Subjective norms	-0.045	0.106	-0.42	0.672	-0.253	0.163
Egoistic value orient.	0.086	0.079	1.09	0.277	-0.069	0.241
Altruistic value orient.	0.028	0.092	0.30	0.765	-0.153	0.209
Biospheric value orient.	0.014	0.106	0.13	0.895	-0.193	0.221
Green lifestlye	-0.045	0.169	-0.26	0.792	-0.376	0.287
Involvement in movement	-0.042	0.116	-0.37	0.713	-0.269	0.184
Past donation	0.256	0.101	2.54	0.011	0.058	0.453
Env-econ trade-off	0.031	0.129	0.24	0.811	-0.222	0.283
Familiarity with VCOs	-0.167	0.141	-1.18	0.236	-0.443	0.109
Past purchase of VCOs	0.241	0.359	0.67	0.501	-0.462	0.945
Frequency of flying	-0.097	0.148	-0.65	0.513	-0.388	0.194
Covid-19 impact	0.166	0.233	0.71	0.476	-0.291	0.623
Gender (male)	-0.234	0.224	-1.04	0.297	-0.674	0.206
Age	-0.004	0.011	-0.35	0.724	-0.025	0.017
Income	0.000	0.000	0.66	0.511	0.000	0.000
Kids	-0.011	0.109	-0.10	0.918	-0.226	0.203
Political orientation (base=center)						
Left	-0.179	0.252	-0.71	0.477	-0.673	0.314
Right	0.086	0.320	0.27	0.789	-0.542	0.713
Education level (base=high school or less)						
Undergraduate or professional degree	0.152	0.250	0.61	0.542	-0.338	0.643
Master's or doctoral degree	0.097	0.322	0.30	0.764	-0.535	0.729
Employment status (base=full time)						
Part time employed	-1.043	0.358	-2.91	0.004	-1.745	-0.341
Self-employed	0.293	0.353	0.83	0.408	-0.400	0.985
Unemployed	0.206	0.469	0.44	0.661	-0.714	1.125
Other	-0.472	0.345	-1.37	0.171	-1.147	0.204

***** *Significant at p < 0.05, ** significant at p < 0.01.*

Appendix 13b: Crosstabulation of attitude-behaviour gap and donation to environmental causes

Donation	A	B	C	D	Total
Strongly disagree	15	8	11	40	**74**
Disagree	26	18	18	27	**89**
Neither agree nor disagree	30	14	32	31	**107**
Agree	40	12	55	30	**137**
Strongly agree	12	4	25	17	**58**
Total	**123**	**56**	**141**	**145**	**465**

Note

A	*Positive attitude, yes behaviour*
B	*Negative attitude, yes behaviour*
C	*Positive attitude, no behaviour*
D	*Negative attitude, no behaviour*

Appendix 14: Proof of payment to voluntary carbon offsetting providers

REPUBLIC OF SLOVENIA
MINISTRY OF FINANCE
PUBLIC PAYMENTS ADMINISTRATION OF REPUBLIC OF SLOVENIA

SUB-ACCOUNT DEBIT CERTIFICATE

Title of box	
Related reference number	SE22062973453391
BoS Reference mark	BP00006345939240
Settlement system	
Date of transfer execution	29.06.2022
Time of transfer execution	08:02:59

Amount of transfer and currency	121,00 EUR
Amount of transfer and original currency	121,00 EUR
Payer - Account - Name - Address - Postal code	 011006030708574 UL EF KARDELJEVA PLOŠČAD 017 1000 LJUBLJANA
Debit reference	00 0000070968
Beneficiary bank - BIC code - Bank name - Bank address - National clearing code of the bank	 GENODEM1GLS
Beneficiary* - Account - Name - Address - Postal code	 DE06430609674009153300 ATMOSFAIR GGMBH HARZER STR. 39 12059,BERLIN
Credit reference	00 AX1000674233
Purpose of payment	PAY. OF INVOICE AX1000674233
Type of costs	SHA

*Data on the name of the beneficiary were provided by the budget user.

SUB-ACCOUNT DEBIT CERTIFICATE is extracted from the online application UJPnet, 26.07.2022 15:18

Signature of authorised person of PPA:

mag. Aleksandra Miklavčič
Director-General

Public Payments Administration of the Republic of Slovenia, Dunajska 48, PO Box 2621, 1001 Ljubljana

REPUBLIC OF SLOVENIA
MINISTRY OF FINANCE
PUBLIC PAYMENTS ADMINISTRATION OF REPUBLIC OF SLOVENIA

SUB-ACCOUNT DEBIT CERTIFICATE

Title of box	
Related reference number	SE22063081478341
BoS Reference mark	BP00006354643950
Settlement system	
Date of transfer execution	30.06.2022
Time of transfer execution	08:20:21

Amount of transfer and currency	155,00 EUR
Amount of transfer and original currency	155,00 EUR
Payer - Account - Name - Address - Postal code	 011006030708574 UL EF KARDELJEVA PLOŠČAD 017 1000 LJUBLJANA
Debit reference	00 0000071289
Beneficiary bank - BIC code - Bank name - Bank address - National clearing code of the bank	 GENODEM1GLS
Beneficiary* - Account - Name - Address - Postal code	 DE72430609677044854800 MYCLIMATE DEUTSCHLAND GGMBH KURRERSTR. 40/3 72762,REUTLINGEN
Credit reference	00 16725703
Purpose of payment	PAY. OF INVOICE 16725703
Type of costs	SHA

*Data on the name of the beneficiary were provided by the budget user.

SUB-ACCOUNT DEBIT CERTIFICATE is extracted from the online application UJPnet, 26.07.2022 15:20

Signature of authorised person of PPA:

mag. Aleksandra Miklavčič
Director-General