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Factors influencing the willingness to pay for aviation voluntary carbon offsets: A literature review

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Abstract
One measure to mitigate the carbon emissions created from air travel is voluntary carbon offsets (VCO). As a voluntary measure, the question of whether there is willingness to pay (WTP) for VCOs and due to what factors is as old as the concept itself. A vast amount of literature has studied the factors influencing WTP for VCOs, producing diverse but also contradictory results. In order to shed new light on the question of which factors influence air passengers' WTP, a systematic quantitative literature review assessing the existing literature on this topic was conducted. Out of 332 studies, 47 articles published between 2004 and 2020 were selected and analysed. The results showed that the highest WTP can be found among young, high-income and highly educated air travellers that are aware of aviation's contribution to climate change and feel personally responsible for their own contribution to it. Gender played no role in WPT. In terms of the offsetting programs themselves, they should be built to create trust in their effectiveness, establish a clear link between customers' paying and the positive outcome for the environment, be transparent, not be priced too high and, most importantly, air passengers should be made aware of their existence.

Keywords: Voluntary carbon offset, willingness to pay, tourism, aviation industry, literature review

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1. Introduction

According to Lenzen *et al.* (2018), tourism contributes to about 8% of global greenhouse gas emissions. The major impact stems from air travel, which is estimated to be responsible for 50% to 95% of tourism's total contribution to global climate change (Dwyer *et al.*, 2010; Gössling & Peeters, 2007; Peeters & Schouten, 2006; Sharp *et al.*, 2016). If one looks at air travel on an individual level, it must be acknowledged that it is one of the most energy-intensive forms of transportation. This is why it was, for example, considered the biggest individual climate sin in an article by *The New York Times* (Rosenthal, 2013). Even after the steep drop in emissions due to the effects of the COVID-19 pandemic, aviation still accounts for 2% of global energy related carbon emissions in 2021, with rising demand from passengers continuing to outgrow projected reductions (IEA, 2022). At the same time there exists also the challenge of correctly assessing the greenhouse gas emissions of individual flights as calculation methods used vary broadly, producing a wide array of results (Baumeister, 2017).

However, not flying is not always a feasible option because many destinations cannot be reached other than by aircraft, which is why the existing literature has discussed different ways how individuals can mitigate the climate impacts of their flying behaviour. These include flying with airlines that employ a modern fleet (Hagmann *et al.*, 2015), avoiding stopovers (Baumeister, 2017), selecting airlines that have a green image (Mayer *et al.*, 2012; Wittmer & Wegelin, 2012), selecting airlines that use biofuels (Filimonau *et al.*, 2018) or selecting the least polluting flight option with the help of an eco-label (Baumeister *et al.*, 2020; Baumeister & Onkila, 2018).

Nevertheless, voluntary carbon offsets (VCO) are the form of mitigation which has been most widely discussed and still receives growing attention in the literature. For the time span between 2000 to 2014, Spasojevic *et al.* (2018) identified 37 studies that discussed VCOs and linked environmental aspects with the aviation industry. Among air passengers, the demand for VCOs has increased from 0.3 million tons in 2008 to 42.8 million tons in 2018 (Hamrick & Gallant, 2018).

However, despite the growing popularity of VCOs, previous research has indicated low adoption rates among air passengers (Araghi *et al.*, 2016; McLennan *et al.*, 2014; Shaari *et al.*, 2020). One of the reasons for the low adoption rate can clearly be seen in the fact that the previously mentioned mitigation approaches might not necessarily come with a price tag, but VCOs certainly do. VCOs require air passengers to pay an additional fee in the form of a donation on top of the airfare to mitigate the environmental impacts of their air travel. This has, since the beginning, led to a discussion in the literature on air passengers' willingness to pay (WTP) for VCOs and the question of what factors trigger this WTP. The question of whether there is WTP for VCOs and due to what factors is as old as the concept itself.

Numerous studies have investigated the factors influencing air passengers' WTP for VCOs. They have tried to explain what triggers air passengers' WTP based for example on demographic factors (e.g. Fatihah & Rahim, 2017; Mair, 2011, Shaari *et al.*, 2020), behavioural factors (e.g. Araghi *et al.*, 2016; Choi & Ritchie, 2014; Sonnenschein & Mundaca, 2019), attitudinal factors (e.g. Becken, 2007; Davison *et al.*, 2014) or the way carbon offset programs are designed (e.g. Hinnen *et al.*, 2017; Schwirplies *et al.*, 2019). The findings of these studies are very diverse, however, and often contradict each other. For example, Mair (2011) examined whether older, female consumers would show more WTP for VCOs but could not confirm this hypothesis, while Rice *et al.* (2020) was able to proof the opposite. In addition, existing studies are often limited geographically to papers that, for example, study air travellers in Hong Kong (McKercher *et al.*, 2010), the Netherlands (Brouwer *et al.*, 2008) or Sweden (Gössling *et al.*, 2009). Other studies again have a limited focus on specific sociodemographic groups such as university students and staff (Choi & Ritchie, 2014), government employees (Fatihah & Rahim, 2017), or young frequent travellers (MacKerron *et al.*, 2009).

Because the existing literature does not provide a clear picture of which factors influence air passengers' WTP for VCOs or even provide contradicting views, a systematic quantitative literature review was conducted to fill this gap, screening 332 scientific studies. Based on this large amount of studies, 47 papers were selected for in-depth analysis. This study tries to shed new light on the question of which factors support, hinder or have no effect on the WTP for VCOs. In addition to that, it also tries to fill existing gaps in literature which is often limited geographically or to certain sociodemographic groups. This paper is structured as follows: We start by discussing carbon offset mechanisms before taking a closer look at the concept of WTP for pro-environmental goods. In the method section we explain the systematic quantitative literature review method, then we present the results of our literature review. Finally, we discuss and draw conclusions on the factors supporting, hindering or having no effect on the WTP for VCOs.

2. Carbon offset mechanisms

Carbon offsetting can be understood as one potential approach to reduce the environmental impact caused by the consumption of products and services. The term "carbon offset" refers to an amount of carbon dioxide equivalent which has not been emitted to the atmosphere due to a reduction measure or sequestration efforts from projects on the ground (Hamrick & Gallant, 2017).

Carbon emissions can be offset in different ways. For instance, by carbon avoidance or by carbon sequestration from the atmosphere. Alternatively, in renewable energy offset projects the emitted CO_2 (resulting from fossil fuel consumption) is offset in the form of creating new plantations, implementing forest protection and/or reforestation activities in a specific location. In the future, these new plantations provide carbon sequestration by absorbing carbon emissions from the air (Becken & Mackey, 2017). Polonsky *et al.* (2011) grouped carbon offsetting practices into four different categories by their nature, namely:

- biological sequestration by preserving or planting trees to absorb carbon from the atmosphere
- developing renewable energy projects which produce energy without emitting carbon dioxide
- increase energy efficiency measures to reduce emissions
- reduction of non-CO_2 GHG from specific sources.

Independent commercial offset providers and non-governmental organizations (NGOs) offer multiple ways of offsetting emissions with varying allocation methods and prices (Gössling *et al.*, 2007). Consumers interested in offsetting their carbon emissions can directly purchase these services from service providers or give donations to the NGOs equivalent to the amount of carbon to be offset. These organizations then implement projects that reduce carbon from the atmosphere. There is also a possibility to purchase so called carbon credits from carbon markets. This credit amount is connected to the amount of CO_2 to be offset and the credit acts as an intermediary (Hamrick & Gallant, 2017). These offset activities are often verified by a third party (Gössling *et al.*, 2007).

Nevertheless, carbon offsetting has been widely debated within the research community in regards to its estimated effectiveness (Cook-Patton *et al.*, 2020), transparency (Babakhani *et al.*, 2017; Chen *et al.* 2021) and credibility (Kreibich & Hermwille, 2021). Carbon-offsetting services create co-benefits in various forms, such as the conservation of nature's biodiversity due to forest protection activities implemented by carbon offsetting projects. In addition, these offset projects have created economic benefits for local communities and improvements in human health and development (Babakhani *et al.*, 2017; MacKerron *et al.*, 2009). Aside from direct benefits to local communities, MacKerron *et al.* (2009) demonstrated indirect benefits such as increased media coverage to raise awareness of climate

change. MacKerron *et al.* (2009) go on to suggest that increased engagement in carbon offsetting can be interpreted as support for pro-environmental policies for decision makers.

Carbon offsetting, however, has received criticism as being the second-best option compared to simply avoiding emissions in the first place. Carbon offsetting allows consumers to continue their consumption in the same way, but with reduced feeling of guilt. Offsetting can be seen also as a loss of opportunity to steer individuals towards more pro-environmental behaviour (Bösehans *et al.*, 2020; Higham *et al.*, 2014). This is especially relevant in the light of hypermobility in air travel (Shaw & Thomas, 2006). Additionally, the offset market has frequently been criticized for various issues, most notably for lack of trust and transparency when consumers questioned the connection between paying money and saving the environment (Choi & Ritchie, 2014; Higham & Cohen, 2011; Higham, Cohen *et al.*, 2016). These issues have been prevalent since the emerging of this market (Gössling *et al.*, 2007). Baumeister (2017), for example, found substantial differences across organizations providing offset services, in terms not only of prices, but also regarding emission calculations and evaluation criteria. These kinds of variations, for instance in method of calculation, negatively affects the credibility of the market (Bösehans *et al.*, 2020; Higham *et al.*, 2014).

3. WTP for Pro-Environmental Goods

The desire to offset carbon emissions is closely linked to the concept of willingness to pay, which dates back to Davenport (1902). WTP provides valuable insights, not only on price elasticities, but also on factors that influence the consumer´s decision-making process and is commonly defined as the "[...] maximum price a buyer accepts to pay for a given number of goods or services" (Le Gall-Ely, 2009). WTP explores consumers' attitudes towards the question of whether a consumer is willing to purchase a certain product and at what price.

Regarding WTP for pro-environmental goods related to the airline industry, Hinnen *et al.* (2017) identified several products offered by airlines, such as carbon neutral transfers to the airport, organic meals, the possibility to purchase sustainable products on-board and VCOs. In addition, there also exists the opportunity for air passengers to pay extra for aspects such as the use of environmentally friendlier airports or flights operated with biofuels (Rice *et al.*, 2020). Airlines have explored different methods on how to offer these products to their customers, with the most common practice being a standard air fee with optional purchases of supplementary services or goods (Hinnen *et al.*, 2017). In terms of carbon offset, however, Bösehans *et al.* (2020) suggests incorporating the offsetting fee into the airfare to increase adoption. Hinnen *et al.* (2017) supports this argument because VCOs as a product do not offer any co-benefits to air passengers as does, for example, paying extra for organic food, which provides direct health benefits to the consumer.

According to Sonnenschein and Mundaca (2019), there exists WTP among air passengers for VCOs ranging from 14 euros for a short-haul to 36 euros for a long-haul flight. The authors found that WTP depends on socioeconomic factors, local or regional circumstances, elicitation format and the payment vehicle. Other dimensions of WTP previously assessed include the price per flight (Babakhani *et al.*, 2017), price per 100 km of flight distance (Brouwer *et al.*, 2008) or share of ticket price (Akter *et al.*, 2009). In summary, Sonnenschein and Mundaca (2019) clearly identified in their study that the WTP consistently appears to be positive for pro-environmental goods and services in the aviation industry.

4. Methods

This study uses the systematic quantitative literature review approach developed by Pickering *et al.* (2015). In contrast to a traditional, narrative review (see Green *et al.*, 2006), this method provides an objective and replicable methodology while adequately addressing possible biases (Pickering *et al.*, 2015). Additionally, the systematic quantitative literature review can be carried out with fewer resources

than are required for a meta-analysis (see Petticrew & Roberts, 2006) and is feasible when a comparably low amount of literature is available (Pickering *et al*., 2015).

4.1 Keyword identification and search design

In order to select suitable keywords and search criteria, a preliminary review was carried out using GoogleScholar as a database. The search query (SQ): ["carbon" AND "offset" AND "aviation"] was used to identify relevant papers fitting the research question. Thirty-two scientific journal articles were selected for further assessment with a keyword analysis.

Following the recommendations by Pickering and Byrne (2014), only peer reviewed journal articles were included to ensure a high scientific standard and comparability. The credibility of articles was verified by the use of SCImago CiteScore™ while studies not included in the cite score were checked individually by carrying out background checks on the author's publishing history. The papers included in this review were published from 2004 to September 2020. The language of the articles was chosen to be exclusively English, since it is the most common language in research (Hamel, 2007) and would ensure an international perspective. To cover a wider range of articles, a mix of publisher-based databases and interdisciplinary databases were chosen for the review. Databases selected were Emerald Insight (Emerald Publishing), SAGE (SAGE Publishing) and Science Direct (Elsevier) as well as Web of Science, Scopus and ProQuest. The search procedure followed the Preferred Reporting Items for Systematic Reviews (PRISMA) statement by Moher *et al.* (2009).

For the initial databases search, the search terms used in the preliminary review were expanded with synonyms using the Merriam-Webster Thesaurus (Merriam-Webster, 2020) and results from the conducted keyword analysis. This led to the SQ:

"carbon" OR "CO_2" OR "emissions" OR "greenhouse gas emissions" OR "carbon dioxide"
AND
"Offset" OR "Offsetting" OR "compensation"
AND
"aviation" OR "air traffic" OR "air travel" OR "air transport" OR "airlines" OR "flight"

Due to a high number of irrelevant results, the query was further specified by adding frequent keywords. To achieve a more targeted search, the SQ was split up thematically and adapted over time:
SQ1: "Willingness to pay" ("carbon" OR "CO_2" OR "greenhouse gas emissions") (offset* OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "air traffic" OR "flight" OR "airline")
SQ2: "Environmental knowledge" ("carbon" OR "CO_2" OR "greenhouse gas emissions") (offset* OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "air traffic" OR "flight" OR "airline")
Following the initial search, search queries 1 and 2 were employed for a first search through all six databases. Search filters were set to limit the search to the fields "keywords", "abstract" and "title" of the publication, excluding text body and references. There were no limitations in terms of scientific field, date of publishing or other. Identified results were transferred to RefWorks in order to remove duplicates, followed by a manual check to ensure no duplicates remained.

After screening results from the first database search based on search queries 1 and 2, keywords of eligible papers were collected and analysed in order to improve the search queries. This led to the formulation of the four final search queries:

SQ1 (adapted): "Willingness to pay" ("carbon" OR "CO2" OR " emissions") (offset OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "air traffic" OR "flight" OR "airline")*
SQ2 (adapted): environmental ("carbon" OR "CO2" OR "emissions") (offset* OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "air traffic" OR "flight" OR "airline")*
SQ3: "voluntary" ("carbon" OR "CO2" OR " emissions") (offset OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "air traffic" OR "flight" OR "airline")*
SQ4: touris ("carbon" OR "CO2" OR " emissions") (offset* OR "compensation") ("aviation" OR "air travel" OR "air transport" OR "flight" OR "airline")*

Search queries 3 and 4 brought forward some additional papers, however, as the frequency of duplicates increased considerably, the database search was stopped.
In total, there were 321 papers identified for further assessment. The distribution of the identified papers across the databases can be seen in Table 1.

Table 1. *Articles retrieved by search query and database*

	Web of Science	ScienceDirect	SagePub	Scopus	ProQuest	Emerald Insight	Total
SQ1	25	8	0	14	12	23	59
SQ2	34	15	1	45	22	7	117
SQ3	26	10	2	24	26	X	88
SQ4	21	2	1	20	13	X	57
Total	106	35	4	103	73	X	321

After the database search, 11 additional papers were identified by checking the references of selected papers as well as by using the databases "cited by" info to identify papers which were referencing selected papers. The selection criteria remained the same as for the database search.

A total of 332 papers were identified, of which 189 remained after removing duplicates. Of those, 130 were excluded in the screening process. During the screening process, papers on non-voluntary carbon offset schemes and technical carbon reduction methods as well as papers on general climate or environmental impacts of aviation were excluded. While assessing the eligibility, some more papers on specific non-voluntary offset mechanisms such as integrated ticket fees (Bösehans *et al.*, 2020) and studies focusing on actors other than passengers, like offset providers or offset market participants (Gössling *et al.*, 2007) were excluded. Other reasons for exclusion were papers without passenger participation, such as literature reviews (Eijgelaar, 2011; Higham *et al.*, 2019) or an industry-focused approach (Becken & Mackey, 2017). After the screening process an additional 12 articles were removed during the eligibility process after assessing the full text. This led to a total of 47 studies being included in the quantitative analysis (for a detailed list, see the appendix). Figure 1 presents the selection process in more detail. The amount of included papers met Pickering and Byrne's (2014) criteria of 15 to 300 papers for a systematic review.

4.2 Database construction
After the articles had been selected that were included in this study, a database was constructed to collect the simple metrics and information on authors, journals, research design and methods as recommended by Pickering and Byrne (2014). The database was then in a second step expanded, collecting information on the influencing factors for the WTP for VCOs based on the findings of the assessed articles. Altogether 120 influencing factors were identified which were put into five broader categories that emerged during the process: demographics, behaviour, attitudes, offsetting programs and the role of airlines. In a final step each influencing factor was divided into three sub-categories:

positively influencing, negatively influencing and not influencing factor in regard to the WTP for VCOs leading to 360 individual characteristics. Based on the frequency of occurrence of these individual characteristics in the number of articles assessed for this study, conclusions were drawn on how significantly these influencing factors did affect the WTP for VCOs.

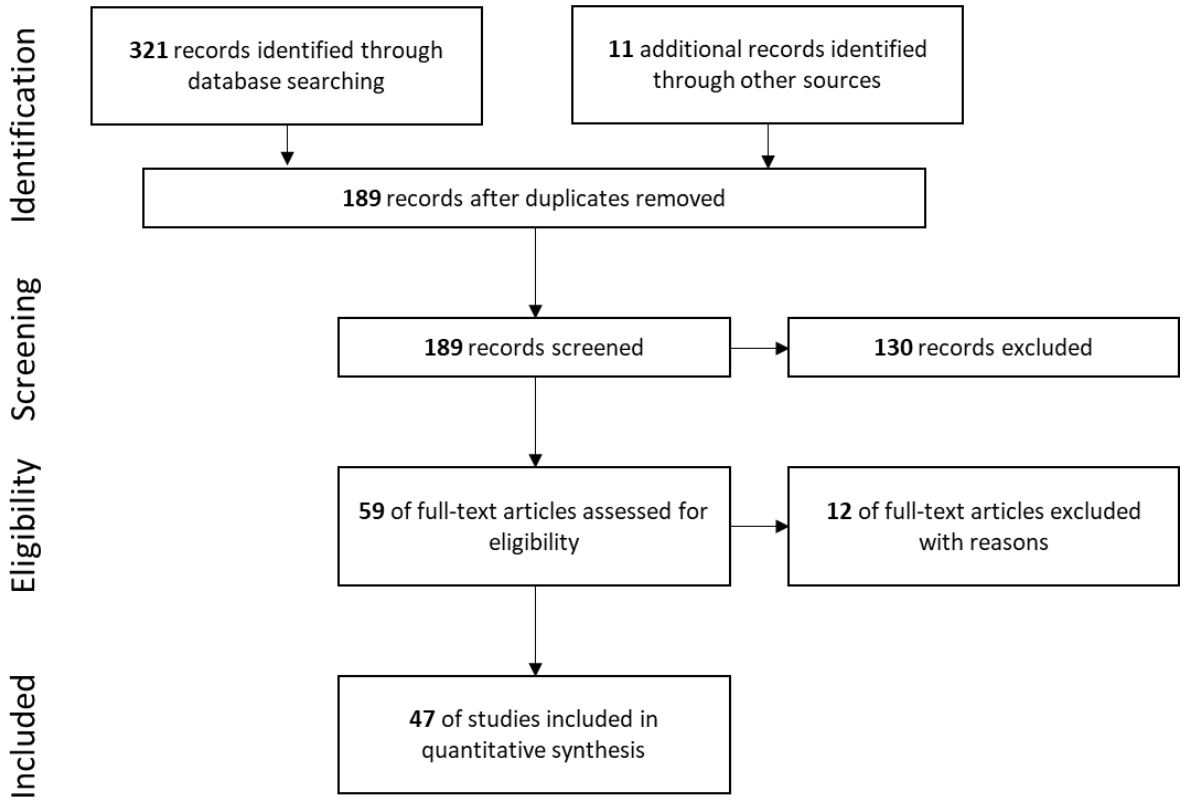


Figure 1. *PRISMA flow-chart of selected and excluded studies*

5. Results

5.1 Descriptive analysis

First, research and journal data were assessed, including information on authors, year, journal category and journal metrics. The data source for the metrics was CiteScore™ by Scopus, partially supplemented by the SCIMago Journal Ranking. The papers included in this review were published from 2004 to 2020. This time period is marked by increasing environmental awareness as well as the continued emergence of commercial offset providers which had begun in the late 1990s (Gössling *et al.*, 2009). This also explains the increasing number of articles published over the time period studied as indicated in Figure 2. An assessment of the authorship of studies, including co-authorship, found that 7 out of 47 papers were linked to Ritchie Brent, Stefan Gössling, James Higham and Andy Choi, with each contributing to four of the reviewed articles. Although this increases the risk of bias due to the strong influences of single authors on the overall results, it should be noted that this was expected due to the narrow approach of this study.

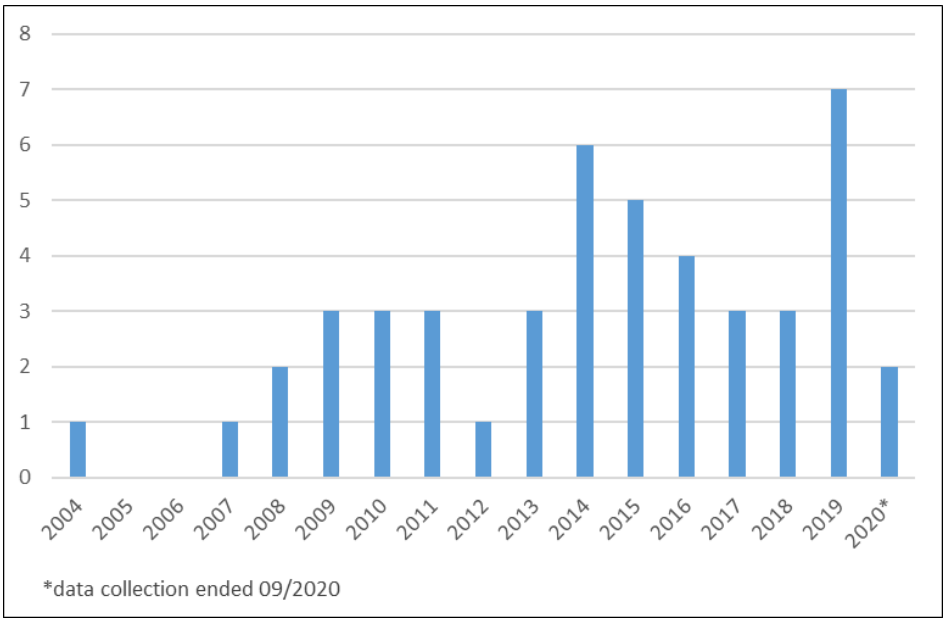


Figure 2. *Number of studies published per year*

Data collected on the research design and research approach showed 70% of studies were quantitative, while 17% were qualitative and 13% mixed-method approaches. Within the wide variety of methods used, surveys and interviews were the most common, often combined with contingent valuation, focus group research, logistic regression and structural equation models. However, two studies approached the subject through behaviour observation (Becken, 2007; Tyers, 2018), and one conducted a psychophysiological lab experiment (Babakhani *et al.*, 2017). Cooperation between researchers and airlines only occurred in five studies. These included three studies involving Qantas (Babakhani *et al.*, 2017; Zhang *et al.*, 2019a, 2019b), one with SAS and Lufthansa (Gössling *et al.*, 2009), and another with Malaysia Airlines and Air Asia (Shaari *et al.*, 2020).

The geographical distribution of studied populations as shown in Figure 3 had a strong focus on Europe and Australia, with some additional studies from Asia, North America and Africa. It should be noted that this distribution is partially linked to the comparatively low number of authors who published multiple papers. An additional reason could be the public interest and controversies in the respective regions, which is referring to the introduction and later abolishment of a carbon tax in Australia (Choi *et al.*, 2018) and a discussion on moral implications of flying in Germany and Sweden (Bösehans *et al.*, 2020).

The studied population had a strong tendency towards including more younger and higher educated participants. The reasons for this trend were either an explicit focus on these groups (Babakhani *et al.*, 2017; Thunström *et al.*, 2014; Tyers, 2018), the results of snowball sampling (Higham *et al.*, 2014; Higham, Cohen *et al.*, 2016) or societal reasons (Dickinson *et al.*, 2013). The results might, however, still be applicable to the general public, as some studies found these factors to be non-influential on WTP (Akter *et al.*, 2009; Hinnen *et al.*, 2017).

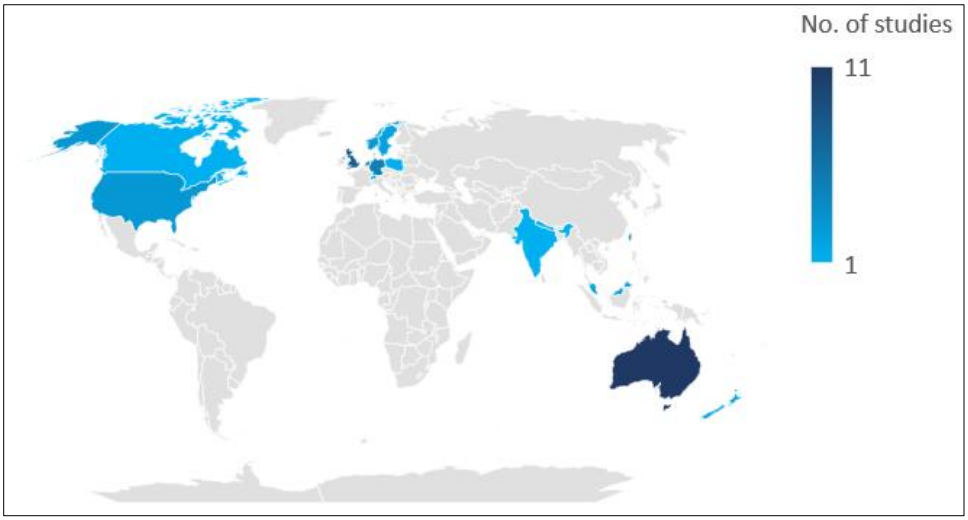


Figure 3. *Geographic distribution of studied populations*

5.2 Influences on WTP

In total, 120 different influencing factors were collected from the result sections of the reviewed papers and grouped into five categories. These included "Demographics" (27 factors), "Behaviour" (32 factors), "Attitudes" (28 factors), "Offsetting programs" (25 factors) and "Role of airlines" (8 factors). This led to 360 individual characteristics, since each factor could occur in a negative, neutral and positive manner. Figure 4 provides an overview of the influencing factors with an occurrence in more than two studies.

5.2.1 Demographics

Most of the common demographic factors (age, gender, income, and education) that have been frequently investigated in previous studies showed differing results with a strong tendency towards neutrality. In particular, the role of age and gender to predict the likelihood of paying for VCOs has been studied widely. While the frequently cited study by Mair (2011) tested and rejected the hypothesis that older females were more likely to engage in VCO, other studies confirmed that older age (Fatihah & Rahim, 2017; Lu & Wang, 2018; Shaari *et al.*, 2020) or being female (Choi & Ritchie, 2014; MacKerron *et al.*, 2009) positively influenced WTP. Reasoning for these and other demographic influences varied across studies. While Fatihah and Rahim (2017) argued that older individuals are more concerned about future generations, Segerstedt and Grote (2016) found younger individuals to be more susceptible to the marketing of VCOs. Additionally, McLennan *et al.* (2014) found young age to be associated with other pro-environmental attitudes and lifestyle choices. These findings could also be related to the cultural and socio-economic background of study participants, as Fatihah and Rahim (2017) conducted their study in Malaysia while Segerstedt and Grote (2016) in Germany, although this dimension has not been investigated further in our study.

In addition to the most common demographic factors discussed above, other factors such as nationality, religion or political orientation were included in some of the studies. Studies which assessed, for example, differences between the nationalities of passengers (Brouwer *et al.*, 2008; McLennan *et al.*, 2014) found comparatively lower WTP among study participants from Asia. Studies conducted within Asia found that adoption rates were indeed very low and in part below 1% (McKercher *et al.*, 2010; Shaari *et al.*, 2020); however, the stated WTP with an average of 74.1% was actually higher than the 56.5% average among Europeans. This highlights an extreme attitude-behaviour gap, but also indicates a strong potential for future implementations of VCOs.



Figure 4. *Influencing factors with a frequency of occurrence >2*

5.2.2 Behaviour

The frequently assessed flight and travel behaviour also highlighted contradicting reasoning for various behaviours. Akter *et al.* (2009), among others, found no significant differences based on the frequency of flights, Araghi *et al.* (2016) identified a stronger WTP in less frequently flying passengers. Araghi *et al.* (2016) linked this to the lifestyle of passengers, who would gain more utility from offsetting their emissions if flying was not part of their lifestyle.

Among the various travel occasions assessed across studies, business travel was the most commonly studied (Jou & Chen, 2015; Lu & Shon, 2012; Lu & Wang, 2018). Even though other travel occasions have been studied, such as family travel (Brouwer *et al.*, 2008), group travel (Tyers, 2018), or travel for nature and sports (McLennan *et al.*, 2014; Segerstedt & Grote, 2016), it was not possible to draw any valid conclusions based on these studies. In terms of business travel, existing studies found traveling for work to have more of a negative influence on WTP (Jou & Chen, 2015; Lu & Shon, 2012; Lu & Wang, 2018; McLennan *et al.*, 2014) than a neutral one (Brouwer *et al.*, 2008; Schwirplies *et al.*, 2019). However, McLennan *et al.* (2014) pointed out that offsets could be undertaken by the company on behalf of the traveller, making the actions of the travellers themselves obsolete.

In respect to the distances travelled, multiple studies (Choi & Ritchie, 2014; Gössling & Schumacher, 2010) found increased WPT on short-haul flights. This pattern can be linked to the lower total amount of CO_2 produced and the subsequently lower price of VCOs (Brouwer *et al.*, 2008; Gössling & Schumacher, 2010). In addition, other behaviour was sporadically assessed, highlighting some interesting findings. For example, frequent participants of video conferences are less likely to offset (Lu & Wang, 2018) and people donating to charities show more WTP for VCOs (Schwirplies *et al.*, 2019).

Finally, financial aspects in general also had a strong tendency to positively influence WTP when they result in lower costs for passengers. This refers to more than the actual price of VCOs as shown, for example, in the studies of Shrivastava *et al.* (2019) and Sonnenschein and Mundaca (2019). It also relates to the study participants' financial situation concerning their demographics, such as income and occupation, as the study by Jou and Chen (2015) and Khand (2019) highlighted. In addition, Choi and Ritchie (2014) as well as Mair (2011) highlighted the convenience of purchase to be crucial for the adoption of VCOs. These findings are in line with the arguments by Schwirplies *et al.* (2019) and Sonnenschein and Mundaca (2019), who both referred to the low-cost hypothesis in their respective studies. According to the hypothesis, the environmental concern of individuals influences their environmental behaviour, especially in situations where low costs and minimal inconvenience are involved (Diekmann & Preisendörfer, 2003).

5.2.3 Attitudes

Another aspect which showed uniform consensus among researchers and was assessed in a majority of studies was the theme of responsibility. Study participants who felt personal responsibility for their CO_2 emissions had higher levels of WTP (Chen, 2013; Davison *et al.*, 2014; Hares *et al.*, 2010; van Birgelen *et al.*, 2011), while a lack of responsibility negatively influenced WTP (Becken, 2007; Kroesen, 2013; Lu & Shon, 2012). These insights were complemented by the findings of Gössling *et al.* (2009) and Hardisty *et al.* (2019), who found passengers' shift of responsibility to parties such as airlines and industry to be of negative influence. Shared responsibility, on the other hand, positively influenced the WTP of passengers, as multiple studies noted (Gössling *et al.*, 2009; Lu & Shon, 2012; Schwirplies *et al.*, 2019).

Although it could have been assumed that the same consensus would appear regarding participants' awareness of aviation's contribution to climate change and scepticism on the link between aviation and climate change, the studies assessed presented differing results. Choi *et al.* (2016) found lower WTP among study participants who thought their flight contributed to climate change. Choi *et al.* (2016) suggest that this could be explained by a shift of responsibility, which was also proposed by Gössling *et al.* (2009) and Lu and Shon (2012). Additionally, the study by Gössling *et al.* (2009) found only a small difference and a generally high level of WTP between climate sceptics (63%) and concerned passengers (72.9%). Gössling *et al.* (2009) further found that travellers see themselves to be the least responsible actors, seeing the responsibility rather with the airline industry, aircraft manufacturers, governments or intergovernmental organizations. In contrast, Choi and Ritchie (2014) even found climate sceptics to be more likely to participate in VCOs. While aware travellers would shift the responsibility to others, climate sceptics could participate in VCOs due to supporting co-benefits like forest protection and biodiversity conservation efforts (Choi & Ritchie, 2014).

5.2.4 Offsetting programs

As for the offset programs themselves, researchers assessed factors related to program content and type as well as the perception of passengers. While there were no clear preferences among passengers for certain program types and methods, such as renewable energy or planting trees or domestic vs. international offset projects (Hinnen *et al.*, 2017; Schwirplies *et al.*, 2019), their perception of the programs produced coherent results. A lack of awareness (Dodds *et al.*, 2008), lack of knowledge

(Fatihah & Rahim, 2017), and lack of transparency (Schwirplies *et al.*, 2019) were among the most common negative influencing factors. Ultimately, these problems cause scepticism in passengers on the link between paying money and in return saving the environment (Higham, Reis, & Cohen, 2016; Zhang *et al.*, 2019b).

5.2.5 Role of airlines

Some of these problems also occurred in respect to airlines, although this field was less commonly assessed. Most notably, a lack of communication by airlines, which was assessed by Zhang *et al.* (2019b) and Higham, Reis, and Cohen (2016), presented a frequent negative influence. Studies focusing on message framing, such as how airlines presented information on VCOs in order to encourage passengers to offset their emissions, found that these messages were not very appealing to passengers (Babakhani *et al.*, 2017; Zhang *et al.*, 2019b). This points to issues in regard to the marketing of VCO, but also provides an opportunity to increase VCO adoption rates (Zhang *et al.*, 2019b).

5.3 Factors influencing WTP

After discussing the 120 different influencing factors based on the five identified categories, we would next like to draw attention to the factors which were found in the reviewed literature to influence WTP the most. We divide the discussed factors into three categories of impact on WTP: positive, neutral, and negative. We limit the discussion to those influencing factors that were identified in at least five studies. We focus the discussion on those factors which positively or negatively influence WTP. Neutral factors are only briefly touched on. Table 2 provides an overview of the factors influencing WTP for VCOs.

5.3.1 Positively influencing factors

In terms of factors that were found to positively influence WTP among air passengers, the demographic factor of high income was identified most often. Eight studies (e.g., Akter *et al.*, 2009; Brouwer *et al.*, 2008; Jou & Chen, 2015) named high income as a positively influencing factor. The second and third most often identified factors influencing WTP for VCOs were both based on attitudes and both found by seven studies as positively influencing factors. These were feeling personally responsible for climate change (e.g. Choi *et al.*, 2018; Davison, 2014; van Birgelen *et al.*, 2011) and the awareness of aviation's contribution to global climate change (e.g. Becken, 2004; Dickinson *et al.*, 2013; Lu & Wang, 2018). The fourth most often named factor that had a positive influence on WTP was again demographic. Five studies (e.g., Schwirplies *et al.*, 2019; Segerstedt & Grote, 2016) found that young age groups tend to show more WTP for VCOs. Another two factors were found by five studies to positively influence WTP, both falling into the offsetting program category: trust in the program's effectiveness (e.g. Choi & Brent, 2014; Ritchie *et al.*, 2020) and a low price for VCOs (e.g. Akter *et al.*, 2009; Higham *et al.*, 2014; Sonnenschein & Mundaca, 2019). Further factors positively influencing WTP for VCOs named by at least four studies were high education, feeling guilty, support for national climate change policy (e.g. Choi, 2015), awareness of the existence of VCO schemes, and support for domestic offset projects.

5.3.2 Negatively influencing factors

In terms of negatively influencing factors, lack of awareness of the existence of VCOs was named the most by 12 studies altogether (e.g. Becken, 2007; Dodds *et al.*, 2008; Higham *et al.*, 2016; McKercher *et al.*, 2010; Zhang *et al.*, 2019b), falling under the category of offsetting programs. The second factor negatively influencing WTP for VCOs came again under the attitudes category. It was the lack of personal responsibility for climate change, named by nine studies (e.g., Hares *et al.*, 2010; Higham *et al.*, 2015; Kroesen, 2013; Shaari *et al.*, 2019). Also named by nine studies as negatively influencing was the lack of trust in the program's effectiveness (e.g. Gössling *et al.*, 2009; Higham & Cohen, 2011; McDonald *et al.*, 2015; Tyers, 2018; Zhang *et al.* 2019a). This as well as the two following factors fell under the category of offsetting programs. The fourth most negatively influencing factor was lack of transparency, highlighted in seven studies (e.g., Babakhani *et al.*, 2017; Higham *et al.*, 2016; Mair, 2011) followed by

high price for VCOs found by six studies (e.g., Akter *et al.*, 2009; MacKerron, 2009; Shrivastava *et al.*, 2019). The following three factors negatively influencing WTP for VCOs were each mentioned five times: shift responsibility to offset to others (attitudes), not being aware of the existence of offsets at all (offsetting programs) and lack of communication/information (role of airlines). Further factors negatively influencing WTP for VCOs named by at least four studies were business as a travel occasion as well as scepticism on the link between paying and saving the environment.

5.3.3 Studied factors that are not influencing

Besides finding a wide array of factors influencing WTP for VCOs positively as well as negatively, the literature review also identified a large number of factors that do not influence WTP. Interestingly, the 10 most mentioned factors all fell under the category of demographics. The most mentioned factors were gender, with male mentioned 14 times (e.g., Araghi *et al.*, 2016; Fatihah & Rahim, 2017; Hinnen *et al.*, 2017; McLennon *et al.*, 2014) and female mentioned 13 times (e.g., Brouwer *et al.*, 2008; Jou & Chen, 2015; Shaari *et al.*, 2020). This was followed by age (middle), 13 times (e.g., Hinnen *et al.*, 2017; Lu & Shon, 2012; Segerstedt & Grote, 2016) and income (medium), 12 times (e.g., Choi & Brent, 2014; Gössling & Schumacher, 2010; Shaari *et al.*, 2020); age (older), 10 times; and income (lower), 8 times. Education was mentioned 7 times for lower and middle education (e.g., Araghi *et al.*, 2016; Fatihah & Rahim, 2017; Schwirplies *et al.*, 2019).

Table 2. *Overview of the most mentioned factors influencing the WTP for VCOs*

Categories	Influencing factors	positive	negative	no effect
Demographic	Income (high)	✓		
	Income (middle)			✓
	Income (low)			✓
	Gender (male)			✓
	Gender (female)			✓
	Age (young)	✓		
	Age (middle)			✓
	Age (old)			✓
	Education (high)	✓		
	Education (middle)			✓
	Education (low)			✓
Behaviour	Travel occasion (business)		✓	
Attitudes	Feeling responsible for climate change	✓		
	Awareness of aviation's contribution	✓		
	Feeling guilty	✓		
	Support for national climate policies	✓		
	Lack of personal responsibility		✓	
	Shift responsibility of offsetting to others		✓	
Offsetting programs	Trust in the effectiveness of VCOs		✓	
	Price (high)		✓	
	Price (low)	✓		
	Awareness of VCO schemes	✓		
	Domestic offsetting projects	✓		
	Lack of awareness of VCOs		✓	
	Lack of trust in VCO effectiveness		✓	
	Lack of VCO transparency		✓	
	Not aware of VCOs at all		✓	
	Scepticism link between paying/impact			✓
Role of airlines	Lack of communication/information		✓	

6. Discussion & Conclusion

6.1 Influences on WTP for VCOs

Of the five categories that were identified from the existing literature, demographics, attitudes and the way offsetting programs are designed were found to be the most influential for WTP. Travel behaviour and the role of airlines as categories played a minor role.

6.1.1 Demographics

Of demographics, gender has been widely studied as an influencing factor in previous research (e.g., Choi & Ritchie, 2014; MacKerron *et al.*, 2009). Nevertheless, our study could not confirm that gender has had any influence on WTP. However, other demographics such as age, income and education did certainly influence WTP according to our findings both positively (age: young; income: high; and education: high) as well as also negatively (income: low).

6.1.2 Attitudes

Regarding attitudes, our findings showed that aspects such as the perceived personal responsibility for climate change, the awareness of aviation's contribution to climate change and also seeing the responsibility to offset with others did influence WTP for VCOs significantly. In addition, increased awareness of aviation's contribution to climate change positively influenced WTP for VCOs. Nevertheless, this finding contradicts Choi *et al.* (2016), who found lower WTP among air passengers who were more aware of aviation's impacts. Choi *et al.* (2016) saw the reasons for this surprising finding in the fact that these air passengers saw that offsetting emissions is the responsibility of others. This finding, on the other hand, was confirmed by our study. Those air passengers who saw offsetting to be the responsibility of others were less likely to offset their own emissions, confirming Choi *et al.* (2016)'s assumption.

6.1.3 Design of offsetting programs

Concerning the way offsetting programs are designed, our results showed that aspects such as the price of VCO, trust in the effectiveness and the transparency of the programs, and the air passengers' awareness of the existence of such programs influenced WTP the most. While several studies (e.g., Hinnen *et al.*, 2017; Schwirplies *et al.*, 2019) assessed air passengers' preference for different types and methods of programs, such as planting trees vs. renewable energy, our results showed that this factor did not have as much influence on the WTP than the previously mentioned factors. On the other hand, the influence of the price of VCOs continued to be an important factor. A low price had a positive influence while a high price had a negative influence on the WTP. This finding confirms the earlier low-cost hypothesis by Diekmann and Preisendörfer (2003) that a lower price for VCOs has a positive influence on WTP.

6.2 Factors influencing WTP

Of the factors influencing the WTP for VCOs various factor positively and negatively influencing factors as well as factors not influencing the WTP were identified in this study.

6.2.1 Positively influencing factors

Of the factors that positively influence WTP for VCOs, demographics, attitudes as well as the design of VCO programs were found to be the most relevant factors. In demographics, the highest WTP for VCOs was found among air travellers that belong to the high income group, who are young as well as highly educated. In terms of attitudes, WTP for VCOs was mainly observed among air passengers that feel personally responsible for climate change and are aware of aviation's contribution to climate change, and among those who feel guilty about their air travel behaviour and in general support national climate change policies. Finally, regarding the design of VCO programs, the most relevant factors were the

trustworthiness of the program's effectiveness, low price, that air passengers are aware of its existence as well as that it supports regional/domestic offset projects.

6.2.2 Negatively influencing factors

For the factors negatively influencing WTP for VCOs, the way in which VCO programs are designed was the prevailing factor. In terms of the design of VCO programs, the most negatively influencing factors were the lack of awareness/knowledge about these programs, the lack of trust in the effectiveness of these programs, the lack of transparency, high price, that participants were not aware of the existence of carbon offset and finally scepticism on the link between paying for VCOs and saving the environment. Besides the design of VCO programs, several other factors were also found to negatively influence WTP. Worth mentioning here are attitudes which showed in both the lack of personal responsibility for climate change and the shift of responsibility to offset for others. Further interesting influencing factors were the lack of communication from airlines (role of airlines), low income (demographics) and business travel as a travel occasion (behaviour).

6.2.3 Studied factors that are not influencing

In terms of influencing factors that had been studied widely in literature but which were found to have neither a negative nor a positive influence on WTP for VCOs, they all turned out to be demographic in nature. The findings clearly showed that gender is not an influencing factor, even though this had been assumed by many previous studies (e.g., Choi & Ritchie, 2014; MacKerron *et al.*, 2009). Moreover, even if passengers belong to the middle and older age groups, this had no influence on their WTP, nor did income if they belong to the lower or middle income groups. Finally, a lower or middle level educational background had no influence on air passengers' WTP for VCOs.

6.3 Managerial implications

Our findings have several managerial implications. They clearly indicated that in order to increase the adoption of VCOs in the aviation industry, the programs should be targeted to those air passengers in certain demographics and who show certain attitudes. These are the young, high income and highly educated air travellers that are aware of aviation's contribution to climate change and who feel personally responsible or guilty for their contribution to climate change. Air passengers of middle and older age groups, medium or low income and medium or low education should not be targeted, neither should air passengers be targeted by gender. Regarding the offsetting programs themselves, they need to create trust in their effectiveness, establish a clear link between customers' paying and a positive outcome for the environment, be transparent, and priced at a low enough level. Most importantly, air passengers should be made aware of their existence.

6.4 Limitations

In terms of limitations, one of the major shortcomings of our approach was the exclusion of non-English literature. The geographic distribution of articles included in our study showed a large share of studies originating from English speaking countries (mainly the UK and Australia) while there was no representation of the Global South. Also, contributions from Asian country remained limited with no notable studies from mainland China. It remains therefore unclear whether VCO are not of interest for those local research communities or studies conducted in these regions remained outside our scope due the exclusion of non-English literature? A further limitation of our approach can be seen in the exclusion of non-peer-reviewed publications which might have added valuable insights to our study.

6.5 Further research

Although this study shed new light on the factors influencing the WTP for VCOs, it left also room for further research. Based on the factors that have been indicated as influencing the WTP for aviation

VCOs, further research could focus more on exactly these factors in order to find ways how to increase the uptake of VCOs. Now as the particular demographics and attitudes of those air passengers that should be targeted are known, further studies could determine how exactly those air passengers could be made more aware of the existence of VCOs.

Appendix

Authors	Year	Title
Akter, S., Brouwer, R., Brander, L., van Beukering, P.	2009	Respondent uncertainty in a contingent market for carbon offsets
Araghi, Y. Kroesen, M., Molin, E., van Wee, B.	2016	Revealing heterogeneity in air travelers' responses to passenger-oriented environmental policies: A discrete-choice latent class model
Babakhani, N., Ritchie, B., Dolnicar, S.	2017	Improving carbon offsetting appeals in online airplane ticket purchasing: testing new messages, and using new test methods
Becken, S.	2004	How Tourists and Tourism Experts Perceive Climate Change and Carbon-offsetting Schemes
Becken, S.	2007	Tourists' Perception of International Air Travel's Impact on the Global Climate and Potential Climate Change Policies
Brouwer, R., Brander, L., van Beukering, P.	2008	"A convenient truth": air travel passengers' willingness to pay to offset their CO_2 emissions
Chen, F.-Y.	2013	The intention and determining factors for airline passengers' participation in carbon offset schemes
Choi, A.	2015	An experimental study to explore WTP for aviation carbon offsets: the impact of a carbon tax on the voluntary action
Choi, A., Gössling, S., Ritchie, B.	2018	Flying with climate liability? Economic valuation of voluntary carbon offsets using forced choices
Choi, A., Ritchie, B.	2014	Willingness to pay for flying carbon neutral in Australia: an exploratory study of offsetter profiles
Choi, A., Ritchie, B., Fielding, K.	2016	A Mediation Model of Air Travelers' Voluntary Climate Action
Davison, L., Littleford, C., Ryley, T.	2014	Air travel attitudes and behaviours: The development of environment-based segments
Dickinson, J., Robbins, D., Filimonau, V., Hares, A., Mika, M.	2013	Awareness of Tourism Impacts on Climate Change and the Implications for Travel Practice
Dodds, R., Leung, M., Smith, W.	2008	Assessing Awareness of Carbon Offsetting by Travellers and Travel Agents
Fatihah, N., Rahim, A.	2017	The Willingness to Pay of Air Travel Passengers to Offset Their Carbon Dioxide (CO_2) Emissions: A Putrajaya Resident Case Study
Gössling, S., Haglund, L., Kallgren, H., Revahl, M., Hultman, J.	2009	Swedish air travellers and voluntary carbon offsets: towards the co-creation of environmental value?
Gössling, S., Schumacher, K.	2010	Implementing carbon neutral destination policies: issues from the Seychelles

Authors	Year	Title
Hagmann, C., Semeijn, J., Vellenga, D.	2015	Exploring the green image of airlines: Passenger perceptions and airline choice
Hardisty, D., Beall, A., Lubowski, R., Petsonk, A., Romero-Canyas, R.	2019	A carbon price by another name may seem sweeter: Consumers prefer upstream offsets to downstream taxes
Hares, A., Dickinson, J., Wilkes, K.	2010	Climate change and the air travel decisions of UK tourists
Higham, J., Cohen, S., Cavaliere, C.	2014	Climate Change, Discretionary Air Travel, and the "Flyers' Dilemma"
Higham, J., Cohen, S.	2011	Canary in the coalmine: Norwegian attitudes towards climate change and extreme long-haul air travel to Aotearoa/New Zealand
Higham, J., Cohen, S., Cavaliere, C., Reis, A., Finkler, W.	2016	Climate change, tourist air travel and radical emissions reduction
Higham, J., Reis, A., Cohen, S.	2015	Australian climate concern and the 'attitude–behaviour gap'
Hinnen, G., Hille, S., Wittmer, A.	2017	Willingness to Pay for Green Products in Air Travel: Ready for Take-Off?
Jou, R.-C., Chen, T.-Y.	2015	Willingness to Pay of Air Passengers for Carbon-Offset
Khand, P.	2019	Air Traveler's Willingness to Pay to Offset Their CO_2 Emission in Pokhara
Kim, Y., Yun, S., Lee, J.	2014	Can Companies Induce Sustainable Consumption? The Impact of Knowledge and Social Embeddedness on Airline Sustainability Programs in the U.S
Kroesen, M.	2013	Exploring people's viewpoints on air travel and climate change: understanding inconsistencies
Lu, J.-L., Shon, Z.	2012	Exploring airline passengers' willingness to pay for carbon offsets
Lu, Jin-Long; Wang, Chiu-Yi	2018	Investigating the impacts of air travellers' environmental knowledge on attitudes toward carbon offsetting and willingness to mitigate the environmental impacts of aviation
MacKerron, G., Egerton, C., Gaskell, C., Parpia, A., Mourato, S.	2009	Willingness to pay for carbon offset certification and co-benefits among (high-)flying young adults in the UK
Mair, J.	2011	Exploring air travellers' voluntary carbon-offsetting behaviour
McDonald, S., Oates, C., Thyne, M., Timmis, A., Carlile, C.	2015	Flying in the face of environmental concern: why green consumers continue to fly
McKercher, B., Prideaux, B., Cheung, C., Law, R.	2010	Achieving voluntary reductions in the carbon footprint of tourism and climate change
McLennan, C., Becken, S., Battye, R., So, K.	2014	Voluntary carbon offsetting: Who does it?
Ritchie, B., Sie, L., Gössling, S., Dwyer, L.	2020	Effects of climate change policies on aviation carbon offsetting: a three-year panel study

Authors	Year	Title
Schwirplies, C., Dütschke, E., Schleich, J., Ziegler, A.	2019	The willingness to offset CO_2 emissions from traveling: Findings from discrete choice experiments with different framings
Segerstedt, A., Grote, U.	2016	Increasing adoption of voluntary carbon offsets among tourists
Shaari, N., Abdul S., Afandi, S.	2020	Are Malaysian airline passengers willing to pay to offset carbon emissions?
Shrivastava, N., Sharma, V., Chaklader, B.	2019	A study to assess impact of carbon credit trading into costs and prices of different goods and services - a study from the airline industry
Sonnenschein, J., Mundaca, L.	2019	Is one carbon price enough? Assessing the effects of payment vehicle choice on willingness to pay in Sweden
Thunström, L., van't Veld, K., F. Shogren, J., Nordström, J.	2014	On strategic ignorance of environmental harm and social norms
Tyers, R.	2018	Nudging the jetset to offset: voluntary carbon offsetting and the limits to nudging
van Birgelen, M., Semeijn, J., Behrens, P.	2011	Explaining pro-environment consumer behavior in air travel
Zhang, B., Ritchie, B., Mair, J., Driml, S.	2019	Can message framings influence air passengers' perceived credibility of aviation voluntary carbon offsetting messages?
Zhang, B., Ritchie, B., Mair, J., Driml, S.	2019	Is the Airline Trustworthy? The Impact of Source Credibility on Voluntary Carbon Offsetting

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