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Mitigating the Climate Change Impacts of Aviation through Behavioural Change

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Abstract

Aviation plays a crucial role for economic development and social welfare, but at the same time it also significantly contributes to climate change. Therefore, if the industry wants to follow the same growth path as it has in the past, it will need to mitigate its environmental impacts more seriously or it may otherwise face regulatory restrictions. The current literature has discussed five mitigation strategies. These are technological changes, market-based changes, operational changes, regulatory changes and behavioural changes. While several authors have regarded behavioural changes as the measure with the greatest mitigation potential, it is also the measure that has received far less attention in the literature. The purpose of this study, therefore, is to investigate the potential of behavioural change as an instrument to mitigate the environmental impacts of aviation. The study is conducted in the form of a literature review. We first discuss issues related to the consumer's environmentally responsible self-concept that often conflicts with the environmental impacts of flying, the so-called flying dilemma. We then provide an overview of aviation's environmental impacts and present the five mitigation strategies in greater detail. After that we have a closer look at the concept of behavioural change. We then discuss separately measures of behavioural change from the perspective of the aviation industry and the air passengers. While the literature on the aviation industry presents many opportunities in which airlines can engage in behavioural change, the literature on air passengers is rather limited and focuses mainly on carbon offset. We instead have chosen another stream of literature that focuses on the novel idea of air passengers engaging in behavioural change by actively selecting airlines which are more environmentally friendly. We conclude this literature review with a discussion of how to bring green offer and demand together by drawing the conclusion that, in order to be able to mitigate the climate change impacts of aviation through behavioural change, an instrument to connect both ends would be needed.

Keywords: climate change; environmental impacts; aviation, airlines; air passengers; behavioural change.

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1. Introduction

Although still heavily debated, there is clear scientific evidence that climate change is mainly caused by human activities through the release of greenhouse gas emissions. In terms of human activities contributing to climate change, electricity and heat production, with a share of 42% of the worldwide CO2 emissions, are the highest, followed by transportation with 23% (IEA, 2015). Although road transportation is the major contributor to the total CO2 emissions of the transportation sector (IEA, 2015), aviation has received the most attention in the public debate, a fact that can be attributed to the high energy intensity of air transportation. Nevertheless, aviation accounts for only about 12% of the CO2 emissions of the entire transport sector (IEA, 2009). Yet though the share of CO2 emissions remains moderate, it is assumed that the warming effects of air transportation might be much higher due to other greenhouse gases such as NOX, CH4 and H2O as well as the differential effects of emissions at different altitudes (IEA, 2009). The real impacts of non-CO2 emissions, however, are still not clearly identified and are heavily debated within science (Preston, Lee & Hooper, 2012).

Aviation currently accounts for about 2.5% of the worldwide CO2 emissions (Lee et al., 2009). Although this does not sound alarming, the industry is growing at a fast rate. In the past the industry saw average growth rates of about 5% annually, doubling its size every 20 years, while at the same time not facing any restrictions on its emissions growth at all (Cohen & Higham, 2011; Dubois & Ceron, 2006). Despite its growing environmental impacts, air transport has become an essential part of our everyday life and has made the global village a reality. Because of its importance for social welfare and mobility, Adler and Gellman (2012) call for more pro-active strategies in order to ensure that further growth would be sustainable, otherwise there might be the regulatory risk of a reduction of air travel, which would certainly harm society and the economy. Although the aviation industry cannot be regarded as a sustainable system (Janic, 2004), it provides social and economic benefits in the form of leisure and business travel, job creation and by sharing knowledge and experiences (Cowper-Smith & de Grosbois, 2011). The globalised economic system as we know it today would not exist without air transportation. Restricting air travel would mean giving up significant benefits for society and the global economy.

According to Daley (2010), the environmental impacts of air travel can be reduced through technological changes, market-based changes, operational changes, regulatory changes as well as behavioural changes. Though both Davison, Littleford and Ryley (2014) and Gössling et al. (2007) see behavioural change as the measure with the greatest potential for mitigating the climate change impacts of aviation, it has, as a measure, received far less attention in the literature than the others. Behavioural change in this context has to be understood as altering behaviour in order to reduce environmental impacts. Although this could certainly be achieved by reducing flights, the social and economic importance of air transportation should not be forgotten. Instead of raising the concern of whether to fly, we want to focus on the question of if there is a possibility to mitigate the environmental impacts by the way in which we fly. Previous research has shown that there are tremendous differences between the environmental performances of individual airlines (Miyoshi & Mason, 2009) and individual flights (Baumeister, 2017). Baumeister (2017) further found that these differences are mainly subject to the individual behaviour of airlines. The purpose of this study, therefore, is to investigate the potential of behavioural change as an instrument to mitigate environmental impacts of aviation without the need to reduce flying.

The study has the following structure. First, the so-called flying dilemma is explained. Next, the environmental impacts of aviation are discussed and the five most prominent solutions are presented. After that, the focus of the study shifts to behavioural change as the primary solution. There is a demonstration of both the potential within the aviation industry as well as among air passengers of how to mitigate the environmental impacts of aviation through behavioural change. The study closes with a discussion of how green offer can meet demand before final conclusions are presented.

2. The flying dilemma

Since its beginning, the airline industry has undergone considerable changes. Air transportation was initially reserved for the rich, but it has turned into a transportation mode for the masses. After the de-regulation of air transport markets in Europe, North America and Australia and the subsequent advent of low-cost carriers, competition has increased, with a resulting significant decrease in air fares (Alamdari & Fagan, 2005; Graham & Vowles, 2006). Air travel has become part of people's lifestyle and a good that is consumed at an increasing rate, with continuously falling

air fares and more and more destinations that are visited more frequently. In the developed world, the idea of taking several foreign holidays per year, including long-haul flights, has almost become normal (Randles & Mander 2011; Shaw & Thomas, 2006). Hares, Dickinson and Wilkes (2010) speak of "hyper-mobility", which is characterised by the increasing length of holidays as well as more frequent short holidays, getaways and weekend breaks. According to Gössling and Peeters (2007), the combination of higher incomes, more leisure time and decreasing air fares (compared to other transportation modes) has made shorter but more frequent trips to more distant locations possible. Yet it is often forgotten that emissions produced by a single long-haul flight can easily exceed an individual's annual emissions allowance (Gössling, Haglund, Kallgren, Revahl & Hultman, 2009). Air travel opens up new opportunities for tourism and leisure, but it is also a significant contributor to climate change. It is estimated that for a vacation including air transportation, 60% to 95% of the impacts on climate change are caused by the flight itself (Gössling & Peeters, 2007; Peeters & Schouten, 2006).

Rosenthal (2013) considers air travel as the biggest individual climate sin. Nevertheless, it seems as if the general public still lives under the impression that individual behavioural change is irrelevant to mitigating climate change, a misconception that seems to be especially strong in the context of flying (Gössling & Peeters, 2007). Even though several studies found that consumers do identify air travel as a cause of climate change (Bonini & Oppenheim, 2008; Brouwer, Brander & van Beukering, 2008), other studies have indicated that there is little willingness to cut back on flying or to sacrifice vacations for the environment's sake (Cohen & Higham, 2011; Lassen, 2010). For many, such changes would be considered a restriction of the personal freedom to travel (Becken, 2007), or they bear the risk of decreasing the quality of life (Mokhtarian, Salomon & Singer, 2015). As Rosenthal (2010) argues, air passengers are caught in a "flying dilemma", where one's individual self-concept as an environmentally responsible consumer conflicts with the environmental impacts of frequent air travel. Ironically, it is the middle-class that is the most environmentally aware (Alibeli & Johnson, 2009) but also the group who flies the most (Randles & Mander, 2009). Though some consumers might act in environmentally conscious ways in everyday situations (e.g. by using public transport, recycling or going paperless), transferring these values to their flying behaviour is considered to be difficult (Barr, Shaw, Coles & Prillwitz, 2010). Both Barr et al. (2010) and Miller, Rathouse, Scarles, Holmes and Tribe (2010) found little willingness among air passengers to change their behaviour. As Gössling et al. (2009) found, only one third of air passengers see themselves as being responsible for the environmental impacts caused by their flying. Davison et al. (2014) see a clear value–action gap when it comes to consumers' knowledge about the environmental impacts of air travel and their actual behaviour. Gössling and Hall (2005) see the reason for the lack of action in the fact that the immediate environmental impacts are not visible when compared to other harmful environmental behaviour such as littering. Gössling and Peeters (2007), however, see responsibility, at least partially, on the aviation industry's side as well due to the industry's actively downplaying the real impacts. Yet numerous examples can be found of how the industry has been actively addressing its environmental impacts (Chapman, 2007; Wittmer & Wegelin, 2012).

3. Aviation's environmental impacts and possible solutions

Air travel is one of the most energy intensive forms of transportation (Gössling et al., 2005), and its major environmental impacts include noise, local air pollution and greenhouse gas emissions (Green, 2003). Of these, greenhouse gas emissions have the most significant long-term impact because of their contribution to causing climate change (Forsyth, 2011). The main contributors to climate change produced by airplanes are carbon dioxide (CO2), nitrogen oxide (NOX), water vapour (H2O), emissions of soot particles, various sulphur oxides (SOX), condensation trails and cirrus clouds (Daley, 2010). Though the aviation industry accounts for about 2.5% of the total CO2 emissions worldwide (Lee et al., 2009), it has been growing at a very fast rate of about 5% annually, doubling its size every 20 years (Cohen & Higham, 2011; Dubois & Ceron, 2006). In recent years the growth has even increased. Between 2003 and 2013 alone, the industry grew at an even faster rate of 6.2% on average, and a further increase in growth is expected, according to the International Civil Aviation Organization (ICAO, 2017a).

Past growth has also had an impact on the emissions released by aircraft. For example, between 1991 and 2003, the carbon dioxide emissions caused by aviation grew by 87% (Rothengatter, 2010). Because the industry itself is currently not facing any restrictions on its emissions growth, it is estimated that aviation's share of worldwide CO2 emissions could increase by a factor between 2.0 and 3.6 between 2000 and 2050 (Owen et al., 2010). Similarly, Macintosh and

Wallace (2009) have predicted a 110% increase in CO2 emissions between 2005 and 2025. This steep increase of the relative contribution of the sector might also be reinforced by emissions reductions achieved in other sectors (Sgouridis, Bonnefoy & Hansman, 2011). Therefore, if the aviation industry shows no progress in reducing its environmental impacts, there is a possible risk that regulation might restrict air transportation's future growth (Adler & Gellman, 2012; Gössling et al., 2007). According to Daley (2010), the environmental impacts of air travel can be reduced through technological changes, market-based changes, operational changes, regulatory changes and behavioural changes.

During the four decades following the 1950s, technological improvements were able to compensate for the immense growth of the industry, keeping its overall impacts rather constant (Green, 2003; Penner, Lister, Griggs, Dokken & McFarland, 1999). As current technology has reached its maturity, however, the efficiency potentials have now all been nearly exhausted (Gössling & Peeters, 2007). Current aircraft technology is locked in because aircrafts have a long life span, while existing aircraft as well as airport infrastructure are difficult to update (Forsyth, 2011). Extensive growth has also pushed the industry's infrastructure to its limits, and the resulting congestion has made the system even less efficient (Janic, 2004). According to the Intergovernmental Panel on Climate Change (IPCC, 1999), the emissions produced through predicted growth can no longer be compensated by emissions reductions based on current technology. In order to achieve significant efficiency gains that would match the predicted traffic growth, a totally new design of aircraft would be needed (Åkerman, 2005). Even if such aircraft were to become available in the near future, the necessary change in infrastructure to accommodate such airplanes at all major airports around the globe would take decades (Green, 2003).

Because technology alone can no longer solve the problem, the focus has turned to other solutions in recent years. Market-based changes such as taxes, charges, subsidies or emissions trading present a set of new solutions (Daley, 2010). They are mainly based on the cost of carbon, which in return should reflect the cost of environmental damage caused by its release (Stern, 2007). One market-based approach that has received attention in the past years is emissions trading. So far, however, emissions trading is only practised within the EU. Scheelhaase and Grimme (2007) suggest that the challenge of integrating aviation into a global emissions trading scheme lies in the divergence of political interests. Another approach, presented by Lu and Morell (2001), are charges for local engine emissions and aircraft noise. Such charges, however, would barely cover the actual social costs, while Lu and Morell (2001) found that they would also not have a significant impact on ticket prices or on passenger demand.

A third solution to mitigate the environmental impacts of aviation is seen in operational changes. Operational changes relate to the reduction of inefficiencies in the operation of aircrafts on the ground and in the air. These inefficiencies are mainly caused by air traffic management (ATM) systems and procedures that result in congestion (Daily, 2010), thereby requiring aircrafts to spend more time in the air or waiting on the ground with their engines running. The IPCC (1999) found that improvements in ATM could reduce aviation's fuel consumption by between 6% and 12%. However, this would require major changes in ATM and more collaboration (e.g. Single European Sky) between the currently fragmented ATM systems (Button & Neiva, 2013).

A fourth solution is seen in regulatory changes. In the past, regulatory changes have mainly focused on the certification of engines and certification limits imposed on newly-manufactured engines. These have been negotiated and agreed through the ICAO Committee on Aviation Environmental Protection (CAEP) with the aim to reduce emissions produced by aircrafts. Nevertheless, ICAO engine certification standards have only centred on NOX emissions, ignoring the most significant pollutant of radiative forcing, CO2 (Daily, 2010). However, in October 2016 the ICAO general assembly introduced the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which included some ground breaking regulatory changes for achieving carbon neutral growth beyond 2020. Although CO2 emissions are finally addressed with CORSIA, the actual scheme, which is voluntary, will not start before 2021 and will only focus on future CO2 emissions, neglecting the existing ones (ICAO, 2017b).

A fifth solution for mitigating the environmental impacts of aviation that has recently been discussed more is behavioural change. Nevertheless, behavioural change as a mitigation strategy has not received much attention in literature yet. Nonetheless, several authors have identified behavioural change as the measure with the greatest mitigation potential. Davison et al. (2014) argue that emissions reductions rely on behavioural change and that other measures, such as technological changes, play only a minor role. Gössling et al. (2007) came up with similar conclusions, suggesting technological and behavioural changes are the two measures that are able to bring aviation back to a sustainable growth path. However, they clearly state that behavioural change plays the key role in this.

Because behavioural change has received less attention in the literature, but has been identified by several authors as playing a key role in mitigating the environmental impacts of aviation, this study will therefore discuss behavioural change in greater detail.

4. Behavioral change

The concept of behavioural change is applied in many fields, including health, education, international development, criminology and mitigating environmental impacts, just to name a few. Broadly speaking, behavioural change refers to any transformation or modification of human behaviour. When looking more closely at behavioural change from the perspective of human impact on the environment, behavioural change can be defined as follows: "Behavior that consciously seeks to minimize the negative impact of one's actions on the natural and built world" (Kollmuss & Agyeman, 2002). In line with that definition, Steg, van den Berg and De Groot (2013) defined behavioural change in this context as "the use of intervention techniques to create or enhance environmentally friendly behavior". Environmentally friendly behaviour or pro-environmental behaviour can hereby be understood as behaviour that reduces the harm caused to the environment or in some cases even creates benefits for the environment (Steg et al., 2013). However, in regard to air transportation, at least in its current form, it always causes harm to the environment. Environmentally friendly behaviour in this context should therefore be understood using air transportation in a way that causes less harm to the environment.

Behavioural change in this context can be understood as a form of mitigating environmental impacts caused by human activities. Such environmental impacts are, according to Stern (2000), a by-product of humanity's desire for status, power, security, enjoyment, maintenance of family and tradition as well as mobility. In recent years, these environmental impacts have become more visible and a connection between these human activities and the impacts has been established. It has been understood that a change in behaviour is needed and that these human activities must be altered in a way that lessens the impact on the environment (Stern, 2000). Hillman (2004) emphasised that humans have to change their behaviour if they want to be able to tackle the problem of climate change. Brewer and Stern (2005) see a great potential for major improvements in reducing environmental impacts from individuals and households by changing their consumption behaviour in areas such as housing, energy, water, food, waste and transportation. In the United States, for example, households alone account for almost half of the carbon emissions (Cutter et al., 2002). This whole discussion has led some consumers to adopt a more sustainable lifestyle by changing their behaviour (Degenhardt, 2002). Kollmuss and Agyeman (2002) state that many different models exist in the literature explaining why consumers adapt a more sustainable lifestyle. On the basis of their own findings, the three main factors for such a lifestyle change are internal factors (awareness, knowledge, values, attitudes, motivation, emotions, responsibilities and priorities), external factors (cultural, social, economic and institutional) as well as demographic factors. The United Kingdom's Department for Environment, Food & Rural Affairs (DEFRA), in its Sustainable Lifestyle Framework, has identified seven consumer categories based on their willingness to act in a sustainable manner: positive greens, concerned consumers, waste watchers, cautious participants, sideline supporters, stalled starters, and the honestly disengaged. The consumers in the first two categories, positive greens and concerned consumers, showed the highest willingness to act. Together, they accounted for about 32% of the entire UK population (DEFRA, 2011). On the basis of this classification, the amount of consumers that are willing to adapt their lifestyle by changing their behaviour can play an important role in mitigating environmental impacts and climate change caused by human activities. Of course, this also has an effect on companies and service providers that offer products which are affected by the change in behaviour, because they have to adapt and change their own behaviour by providing more green offerings as demanded by the market (Dauvergne & Lister, 2010; Nicholls & Opal, 2005; Wüstenhagen & Bilharz, 2006). The discussion will now turn to options for how the aviation industry can change its behaviour in order to respond to the needs of those air passengers that want to alter their behaviour.

4.1. Behavioural change in the aviation industry

In recent years airlines have begun to address environmental issues more seriously. Some operators have even gone beyond compliance (Lynes & Dredge, 2006). By reviewing the CSR reports of 14 leading airlines, Cowper-Smith and de Grosbois (2011) identified seven broader areas where airlines had engaged in behavioural change through concrete

environmental actions. The most common activity was the reduction of emissions in terms of climate change and local air pollution. These reductions were mainly achieved through the reduced use of fuel by employing newer and more fuel-efficient aircrafts, weight reductions on existing aircrafts, the installation of winglets, optimised operational procedures and engine washing. Although these measures require investments, they result in savings, not only in terms of emissions but also costs (Mayer, Ryley & Gillingwater, 2012). While these emissions reductions first require technological changes in the form of new technology, it is ultimately up to the airlines to apply these new technologies, which again requires pro-environmental initiatives instead of just continuing with the old technology. For fleet renewal, it should be noted that the earlier retirement of aircraft does not necessarily reduce any additional impacts because, based on a life cycle assessment conducted by Howe, Kolios and Brennan (2013), 99.9% of the environmental impacts of an aircraft stem from its actual use phase. However, annual technological efficiency gains of about 1% would justify the earlier replacement of equipment before the end of its life-span (Egelhofer, Marizy & Cros, 2007; Sgouridis et al., 2011). Further on, operational efficiency improvements such as using a continuous descent approach, reduced take-off thrust or single engine taxiing could lead to further emissions reduction. In addition, local air pollution could be reduced through the latest engine technology and the use of electrically powered ground equipment such as vehicles and power units.

The second common initiative Cowper-Smith and de Grosbois (2011) identified was noise reduction. This was mainly achieved through the introduction of quieter engines and the alteration of operational procedures such as the continuous descent approach. The third most commonly practised activity was the reduction of waste through, for example, the recycling of on-board waste, office waste and aircraft parts. Other waste reduction measures included the introduction of electronic boarding passes. Waste reduction was followed by the reduction of energy and water consumption. Energy was mainly saved in offices by using LED light bulbs, lowering air-conditioning and heating as well as by the switch to renewable energy sources. Energy savings could also be found in maintenance and training facilities. The use of water was mainly reduced by using rainwater/greywater for washing equipment and through better calculation of the water needed on board of aircrafts. Another focus was on decreasing water pollution through the reduced discharge from maintenance facilities. Airlines also focused on biodiversity. This included efforts to ensure ecological integrity through, for example, the use of environmentally friendly refrigerants, the use of FSC certified paper or alternative de-icing substances. In addition, airlines also reported the sponsorship of various activities to support biodiversity, such as oil spill relief activities, programmes to deter deforestation, and academic research. Finally, Cowper-Smith and de Grosbois (2011) found a list of further initiatives that failed to fit under any broader area, including obtaining environmental management system (EMS) certification such as ISO 14001, sponsorship of environmental organisations and the development of environmental indices.

When Lynes and Dredge (2006) looked more closely at the reasons why some airlines engage in pro-environmental behavioural change, they identified a range of reasons. First, they found that financial cost-benefits, which they describe as both money saved and money earned, from the use of cleaner production methods (e.g. operating more fuel-efficient aircraft) mean not only lower production costs but also a better corporate image. Second, they listed regulatory settings that contain both a good relationship with regulatory bodies as well as the possibility to influence policy making towards tighter environmental regulations. Such changes would also mean competitive advantage for a forerunner. Hagmann, Semeijn and Vellenga (2015), for example, see significant potential for airlines to gain competitive advantage through environmental differentiation. The third reason for engaging in voluntary environmental initiatives was seen in practicing good corporate citizenship. Some airlines want to demonstrate that they care about the environment and that they are responding to the increasing concern among the public. At the same time, there was also the idea of creating demand for flights offered by airlines that engage in voluntary environmental initiatives, a demand which has not existed to date (Lynes & Dredge, 2006). Nevertheless, Mayer et al. (2012) also think that it is not advisable for an airline to focus on the green market segment exclusively, because this segment is still small. Instead, airlines should understand environmental friendliness more as an add-on to their core product, which is the transportation of passengers from point A to point B through the air. The fourth reason discussed by Lynes and Dredge (2006) was airline image, in the form of a positive image in the marketplace, among suppliers and in the eyes of regulatory bodies. A better image can bring market benefits but also strengthen an airline's position in negotiations. As Wittmer and Wegelin (2012) found, a positive environmental image can help an airline to improve its overall image. Finally, Lynes and Dredge (2006) named pressure from industry stakeholders as the fifth motivator for an airline's voluntary environmental initiatives. Here they not only discussed the avoidance of regulatory risks

such as taxes or flight bans but also increased pressure from corporate customers. As more companies have begun to green their supply chains, the environmental performance of airlines has become an issue.

Finally, differences in terms of environmental performance between airlines can also be found in the business model they follow. In particular, the opening of markets through deregulation and the resulting tougher competition has led to efficiency improvements. A business model which stands out in this regard is the low-cost carrier (Alamdari & Fagan, 2005). Barbot, Costa and Sochirca (2008) as well as Coles, Fenclova and Dinan (2011) see the way in which low-cost carriers operate as much more sustainable compared to network carriers, because resources are used more wisely and operations are more efficient. Due to higher seat density, better load factors and the use of winglets, Hagmann et al. (2015) considered low-cost carriers as environmentally friendlier. In terms of emissions trading, low-cost carriers can be seen as the winners of the system because they use more modern and fuel-efficient equipment (Forsyth, 2011). Nevertheless, low-cost carriers have also increased the total environmental impacts of aviation due to the fact that they have generated additional demand which would have not existed otherwise (Adler & Gellman, 2012; Graham & Shaw, 2008).

4.2. Behavioural change among air passengers

After discussing ways airlines can mitigate the environmental impacts of aviation through behavioural change, we now turn to the air passenger's role. In terms of mitigating the environmental impacts of aviation, the role of the consumer has received little attention in literature so far (Dickinson, Robbins & Lumsdon, 2010). The previous literature has mainly investigated behavioural change in the form of motivation and a willingness to pay for carbon offset (e.g. Gössling et al., 2009; Mair, 2011; van Birgelen et al., 2011), or discussed changes of travel behaviour in terms of using alternative transportation modes (e.g. train, boat, coach or car) or avoiding holidays overseas (e.g. Davison et al., 2014; Higham & Cohen, 2011; Sgouridis et al., 2011). However, substituting or avoiding air travel would mean a reduction of flying, which does not correspond with the aim of this study. These options, therefore, will not be discussed any further here.

In regards to carbon offset, it seems that at least some air passengers want to take responsibility for their air travel consumption by compensating for the carbon emissions produced during their flights. Brouwer et al. (2008), for example, found that the motivation among air passengers to pay for carbon offset comes not from existing values such as giving to good causes or charity but from the primary motive to take responsibility by paying for one's contribution to climate change. The motivation was explained as more of a moral obligation paired with concerns about our environment and future generations. This concern might even increase in the future, especially as the environmental impacts continue to grow and the negative outcomes of climate change become more visible (Sgouridis et al., 2011). Furthermore, van Birgelen et al. (2011) found that environmentally friendly behaviour practised in other areas (e.g. recycling) had also strongly influenced the willingness of air passengers to mitigate their climate impacts on flying with the help of carbon offset.

Nevertheless, although carbon offset might help to compensate for some of the climate damage caused by air traveling, its effectiveness has been questioned by various authors. Araghi, Kroesen, Molin and van Wee (2014) see major drawbacks in the limitations of afforestation and a lack of credible calculation methods. Wittmer and Wegelin (2012) criticise how carbon offset allows airlines to outsource their environmental responsibility, transferring it to the air passenger, who in turn may or may not offset the carbon emissions. In addition, Walker and Cook (2009) see a moral question of whether carbon offsets simply deviate from real solutions such as flying less. Finally, carbon offset could also lead to a rebound effect, where air passengers fly more (Eijgelaar & de Kinderen, 2014) because they no longer see environmental harm in air transportation.

Due to the questionable effectiveness of carbon offset, we would like to focus on a different approach that might solve the problem at its cause. Instead of trying to mitigate already produced carbon emissions, we want to focus on the idea of reducing aviation's climate impacts by air passengers actively selecting airlines or flights that are less polluting. To date, however, only a few studies (Hagmann et al., 2015; Mayer et al., 2012; Wittmer & Wegelin, 2012) have discussed this idea as such. As Wittmer and Wegelin (2012) found, environmental initiatives by airlines are certainly appealing to air passengers. Mayer et al. (2012) further found that over half of the participants in their study thought that some airlines took more actions in mitigating environmental impacts than others did. Hagmann et al. (2015) came up with similar results, showing that air passengers actually differentiate between airlines in terms of

environmental performance. Mayer et al. (2012) found that the consumer's perception of an airline as environmentally committed plays a crucial role in building a green airline image. Lynes and Dredge (2006) confirmed this finding when they studied Scandinavian Airline's green image which, as they found, had positively affected the airline's overall image. Mayer et al. (2012) also showed that low-cost airlines were not perceived as less environmentally friendly than network carriers. In terms of concrete actions taken, an airline using newer aircraft was perceived as the most effective way to mitigate environmental impacts by air passengers (Mayer et al., 2012).

Hagmann et al. (2015) also found that the green image of an airline had influenced air passengers' airline choice to some extent. Although environmental issues are not yet a major criteria for the selection of an airline, both Gössling et al. (2009) and Lynes and Dredge (2006) found that air passengers expect airlines to address this issue more seriously. When looking at the criteria for air passengers' flight choice, Hagmann et al. (2015) found that flying non-stop, not price, was the most important criterion. In general, environmental attributes played a significantly lower role in air passengers' flight choice than non-environmental attributes did, but they did affect air passengers' airline choice. Nevertheless, Wittmer and Wegelin (2012) found that ticket price is still more important to air passengers than the environmental responsibility of an airline. Kelly, Haider, Williams and Englund (2007) as well as Randles and Mander (2011) have, however, shown that air travellers do accept additional environmental fees added to their flight ticket if they know for certain that those revenues are used to mitigate climate change. In a recent study by Hagmann et al. (2015) every second air passenger showed a willingness to pay for a less polluting flight.

The previous literature has mainly utilised carbon offset as an instrument to concretely measure air passengers' willingness to pay. Although the outcomes of carbon offset are questionable, air passengers' participation can certainly provide a good estimate of how much willingness there is to pay for mitigating climate change. As van Birgelen et al. (2011) found, air passengers' perception of the environmental impacts of flying significantly influenced the willingness to pay for carbon offset. Yet there remains a huge difference between the stated willingness to pay and the actual amount air passengers paid for carbon offset. Surveys conducted by Brouwer et al. (2008) and van Birgelen et al. (2011) both showed a high willingness to pay, with 84% of the participants in the study by van Birgelen et al. (2011) actually paying for carbon offset, with compensations ranging from 24 euros for short-haul and 55 euros for long-haul flights. In the case of Hagmann et al. (2015), however, only 23% of the participants paid and in Wittmer and Wegelin's (2012) study it was less than 4%. These results show that there are air passengers who are interested in mitigating the environmental impacts of their flying in the form of voluntary donations, but this group is certainly not the majority.

In terms of responsibility for mitigating aviation's impact on climate change, Gössling et al. (2009) found that airlines actually expect passengers to be more active in reducing emissions while at the same time air passengers see that the responsibility lies in the hands of the industry. In addition, Lynes and Dredge (2006) found that, to date, the industry has not perceived much pressure as coming from passengers to increase its environmental performance. More pressure from air passengers would not necessarily be a negative for the industry. Although the mitigation of environmental impacts will create costs for airlines, Forsyth (2011) does not see only disadvantages for the industry's economic situation in such a shift. Mayer et al. (2012) further argue that such a change holds the potential for airlines to focus more on building a green image which in return could attract more customers.

5. How can green offer meet its demand?

This research has shown that aviation has seen tremendous growth in the past but will have to mitigate its environmental impacts better if it also wants to continue growing in the future. Of all the mitigation methods currently available, behavioural change is seen as the one with the greatest potential. Some airlines have already engaged in behavioural change by going beyond compliance and many measures as well as motivators exist to mitigate environmental impacts. Air passengers can also engage in behavioural change by actively selecting airlines which are more environmentally friendly. Some air passengers have certain perceptions of the environmental friendliness of airlines and show even a willingness to pay for less polluting flights.

Although it is clear that behavioural change on both sides – among the industry and air passengers – can lead to the anticipated reduction of environmental impacts, the question that still remains is how to bring both sides together. Obviously, there is green offer and also green demand. As Gössling et al. (2009) found, some air passengers would like to make choices based on an airline's environmental performance, but this is currently not possible due to the lack

of information. It would actually require expert knowledge to really be able to compare the environmental performance of individual airlines or flights (Gössling et al., 2009). Hagmann et al. (2015) identified the lack of suitable measures that help validate the environmental friendliness of airlines as one of the biggest challenges. Nevertheless, Miyoshi and Mason (2009) predicted that once the environmental performance of airlines become available, the demand factor will drive airlines to reduce their impacts in order to stay competitive. However, as the environmental impacts of air transportation are seen as being so tremendous, it is difficult for an airline to differentiate itself as green even though it is doing everything possible to keep its environmental impacts at a minimum (Lynes & Dredge, 2006). Too easily an airline finds itself accused by environmental organisations of greenwashing when trying to communicate its environmental efforts too openly (Walker & Cook, 2009).

Unfortunately, changes in the environmental behaviour of airlines are less visible for air passengers and therefore need to be clearly communicated in order to receive a proper response (Baumeister, 2017). In order to overcome the suspicion of greenwashing, airlines need to find ways how to communicate environmental improvements more clearly (Mayer et al., 2012). Regardless, Lynes and Dredge (2006) also think that the puzzle of how to define and communicate what a green airline actually means has still not solved. Because it is almost impossible for an air passenger to identify environmentally responsible airlines and very difficult for these kinds of airlines to clearly communicate this issue, Baumeister (2017) claims that air passengers need to be able to access the environmental performance of airlines so that they can make better informed choices. This claim is in line with earlier studies by Cohen and Higham (2011) and Hares et al. (2010), who see a clear need for more publically available information on the environmental impacts of air travel in order to lead consumers to behavioural change and to meet climate targets. According to Cowper-Smith and de Grosbois (2011), the current environmental actions of airlines are largely unknown, which certainly limits the extent to which air passengers will take those into account in their decision making. They call, therefore, for the introduction of a standardised framework that would compare and highlight those actions and allow air passengers to make better informed decisions. Analysing the environmental reports of major airlines, Lynes and Dredge (2006) found that several players, such as British Airways and SAS, had been calling for an environmental standard to benchmark but also to monitor the environmental performance of individual airlines. SAS in particular sees a great demand for an indicator that measures the environmental performance of airlines, hereby making airlines environmentally comparable, and that this could effectively stimulate airlines to improve their performance. Cowper-Smith and de Grosbois (2011) also found in several CSR reports that airlines had been developing environmental indices in order to capture their environmental impacts in relation to their outputs. In the view of Lynes and Dredge (2006), the only ways currently available for airlines to communicate their additional environmental efforts are ISO 14001 certification or being listed in the Green Globe 21. However, both ISO 14001 and Green Globe 21 have found little use or recognition within the industry. Another solution has been presented by Baumeister and Onkila (2017), who proposed the use of eco-labels in order to make flights environmentally comparable. Such an eco-label would support air travellers in decision making because it would provide easy access to environmental data at the time of booking, thus becoming a potential driver of behavioural change.

6. Conclusion

This study set out to investigate the potential of behavioural change as an instrument to mitigate the environmental impacts of aviation without the need to restrict flying. It was able to identify a long catalogue of concrete actions the aviation industry could perform in order to mitigate its environmental impacts. However, while the role of the industry in the mitigation process has been discussed widely in the literature, the role of air passengers has received far less attention. Although the air passengers cannot green the aviation industry as such, they can motivate the industry to improve its environmental performance by more actively selecting greener flight options. Nevertheless, this study has clearly shown that there is a need for an instrument to bring green offer and demand together, because identifying green offer is often not easy for those on the demand side. Such an instrument could foster behavioural change that actually leads to the mitigation of aviation's environmental impacts.

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