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Where does flygskam come from? The role of citizens' lack of knowledge of the environmental impact of air transport in explaining the development of flight shame

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ABSTRACT

A growing number of citizens are concerned about the environmental impact of air transport, and aviation has become synonymous with high carbon emissions and global warming, which has led to the development of flygskam (or flight shame) in Europe. While its impact on air traffic remains unclear, flight shame has forced the airline industry to react and better understand its origin. In this research, building on the growing literature on industry and organizational stigma, we assume that flight shame can be partly explained by a distorted public perception of the environmental impact of air transport. Accordingly, we investigate the level of knowledge of the environmental footprint of air transport. Based on a sample of 1018 French respondents, we reveal that more than 90% of respondents overestimate the share of air transport in global carbon emissions. We also show that 98% of the respondents underestimate the reduction in carbon emissions per passenger. Finally, we investigate the awareness of the measures taken by the industry to curb its carbon emissions and highlight, for instance, that 70% of respondents overestimate the fuel consumption of the newest generations of aircraft. Based on these results, we draw lessons for airlines and for the air transport industry to help cope with flight shame in Europe.

1. Introduction

Increasing numbers of citizens feel concerned about the environmental impact of air transport; thus, the need for frequent flying has become an issue in Europe (Gössling et al., 2019). This concern has led to the development of a phenomenon that was initially described in Scandinavian countries as "flygskam", which means the shame of flying (Flaherty and Holmes, 2020). According to advocates of flight shame, reducing flights would significantly reduce carbon emissions, thus limiting global warming.

Over the last few years, flight shaming has gained momentum on social networks while also benefiting from extensive coverage in the press (Becken et al., in press; Mkono, 2020). Nevertheless, its impact on air traffic remains uncertain, with strong differences observed among countries. Independent of its actual impact, flight shame has forced several European governments to take measures to reduce the environmental footprint of the air transport industry through the implementation of additional taxes or bans on domestic flights below a given range. As they face growing criticism and become increasingly stigmatized for their environmental impact (Gössling et al., 2020), airlines and airports must understand how and why the flight shame phenomenon emerged to address this issue (Roulet, 2020).

To date, because flight shame is a recent phenomenon, a limited number of published research articles have discussed this phenomenon (Flaherty and Holmes, 2020; Gossling et al., 2020; Mkono, 2020). Most of these contributions attempt to understand this phenomenon by defining what flygskam or flight shame truly means and how it has developed over recent months or years (Flaherty and Holmes, 2020; Mkono, 2020; Becken et al., in press). The contribution of Gossling et al. (2020) highlights the implications of flight shame in terms of the evolution of social norms and notes that it has not significantly changed the actual behavior of air travelers in Germany. However, while they clearly

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define the phenomenon, most of these articles have paid limited attention to the roots or drivers of flight shame. Understanding why consumers and citizens can become ashamed when they fly is essential for airlines to understand how to react to this phenomenon.

In this research, we argue that the growing literature on industry and organizational stigma (Devers et al., 2008; Roulet, 2020) can shed a useful light on this phenomenon. More precisely, this notion of industry or organizational stigma refers to a collective perception that an organization or an industry possesses a fundamental flaw that discredits the organization or the industry (Zhang et al., 2020). As such, the flight shame phenomenon could be analyzed as a type of industry stigma that affects its organizations (airlines, airports, manufacturers, etc.). Among the different factors explaining the emergence of these types of stigma, Hampel and Tracey (2017) argue that some firms or industries are stigmatized because their stakeholders do not correctly perceive the intentions and practices of the stigmatized firms. As pointed out by various contributions regarding the lack of "carbon literacy" of consumers (Sharp and Wheeler, 2013; Howell, 2018), we assume that a potential explanation of flight shame can be a lack of knowledge or literacy regarding the actual environmental impact of air transport. This absence of knowledge can lead to distorted public perceptions of the environmental impact of air transport with citizens that either under- or overestimate the carbon footprint of air transport. Accordingly, we suggest that flight shame could be explained by a distorted perception of the environmental impact of air transport. Thus, in this research, we investigate the level of knowledge of the environmental footprint of air transport.

To provide answers to our research question, we developed and administered a survey to a sample of 1018 respondents who are representative of the French population. In this survey, several questions were asked regarding the perceived contribution of air transport to global carbon emissions and concerning the evolution of these emissions over time. We reveal that respondents strongly overestimate the contribution of air transport to global carbon emissions and underestimate the progress made by the industry to cut carbon emissions. Based on these distorted perceptions, we draw lessons for airlines and for the air transport industry to cope with the growing trend of flight shame in Europe.

2. Theoretical background

2.1. Environmental impact of air transport

The flygskam (or flight shame) phenomenon is deeply related to the idea that air transport contributes to global warming through its carbon emissions. Implicitly, flight shaming assumes that air transport is a major contributor to carbon emissions such that reducing one's flights will significantly reduce carbon emissions and global warming (Gössling et al., 2019). However, a quick review of the literature regarding the contribution of air transport to carbon emissions shows a very different reality. Most recent references in the transportation, environmental or energy literature state that air transport accounts for 2–3% of global carbon emissions (see, for instance, Staples et al., 2018; Soria Baledón and Kosoy, 2018; Larsson et al., 2019; Schäfer et al., 2019). Nevertheless, these contributions do not assess the carbon footprint of air transport and usually rely on other articles or scientific studies to provide these numbers. For instance, various research articles rely on the conclusions of the Global Carbon Project (2018) study that states that the air transport industry accounts for 2.3% of global carbon emissions. Other articles build upon the assessment performed by the International Council on Clear Transportation (2018) showing that air transport accounts for 2.4% of carbon emissions. In that vein, we are confident that future research will build upon the recent work by Lee et al. (2021), who argue that air transport accounts for approximately 2.1% of carbon emissions. Despite these minor variations in the assessment of the share contributed by air transport, most scholars agree that air transport accounts for 2–3% of carbon emissions (at the global level).

Although a consensus may have been reached regarding the carbon effects of air transport, a debate has been growing regarding the necessity (or not) of considering the noncarbon effects of air transport. In a recent article, Larsson et al. (2019) reviewed some of the latest contributions and explained that according to some scholars, if these noncarbon effects are considered, the air transport industry would account for up to 5% of carbon-equivalent emissions (Bows, 2010; Lee et al., 2010). Once again, the latest study by Lee et al. (2021) aims at clarifying the various carbon and non-carbon effects of aviation and emphasizes the noncarbon effects on the net radiative forcing. In their analysis, they reveal that taking into account carbon and non-carbon effects would increase the contribution of aviation to 3.5% of carbon-equivalent emissions.

Nevertheless, in the remainder of the article, we focus our attention on carbon emissions for two main reasons. First, as pointed out by Larsson et al. (2019, p. 788), "*there is uncertainty about exactly how large these non-CO2-effects are*", with very different values observed from one study to another despite the consensus with respect to the share of carbon emissions. Indeed, Terrenoire et al. (2019) and Lee et al. (2021) confirm that these noncarbon effects are particularly difficult to measure (some of them having a positive or a negative effect on radiative forcing) and that there is still some uncertainty regarding their lasting effects (some effects last several years, while others last only a few hours). Accordingly, to test the literacy of citizens regarding the environmental impact of air transport, it is important to confront their perceptions with respect to consensual and consistent values. Second, studies that consider the noncarbon effects of air transport usually do not utilize the same exhaustive assessment for other industries. As a consequence, these studies lead to an overestimated share of carbon effects from the air transport industry, which is based on an increased carbon-equivalent amount because the carbon-equivalent emissions of other industries are not readjusted accordingly. Therefore, for the remainder of the article, we will discuss only the carbon emissions of the air transport industry.

2.2. Efforts made by the air transport industry to reduce its environmental impact

In addition to evaluating the contribution of air transport to global carbon emissions, it is important to assess the evolution of this industry in recent decades. According to statistics from the International Energy Agency and of the World Bank, over the period from 2000 to 2018, the number of airline passengers grew by 153%, while carbon emissions increased by 28.5% (IEA, 2019; World Bank, 2019). Thus, growth occurred in the absolute value of carbon emissions. However, in terms of relative value, the air transport carbon footprint per carried passenger decreased significantly over the 2000–2018 period. The French Civil Aviation Authority provides more fine-grained statistics regarding carbon emissions and passengers carried in France over the 2000–2018 period, and their statistics indicate that carbon emissions per carried passenger have decreased by 28% over the last 19 years (DGAC, 2019). If many airlines have managed to reduce their carbon emissions per passenger carried, only a limited number of airlines have succeeded in reducing their absolute value of carbon emissions. For instance, the Air France-KLM group was able to reduce its absolute value of carbon emissions by 7% while increasing the number of passengers carried by more than 20% during the period from 2005 to 2018 (Air France-KLM, 2019).

The reduction (at least in relative value) of the carbon footprint of the air transport industry is the result of actions taken by all participants in the air transport industry. Regarding institutions, at the global or European level, the integration of air transport activities in the EU ETS (European Union Emission Trading Schemes) in 2012 or the implementation of CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) by the International Civil Aviation Organization (ICAO) in 2016 contributed to putting financial pressure on airlines to

significantly reduce their carbon emissions (Scheelhaase et al., 2018; Larsson et al., 2019). While these policy measures do not directly reduce carbon emissions, they force airlines to maintain carbon-neutral growth; otherwise, quotas from other airlines would have to be acquired.

In recent decades, aircraft manufacturers have significantly improved the energy efficiency of airplanes while increasingly relying on composite materials (Timmis et al., 2015; Baharozu et al., 2017). In addition, larger aircrafts with a higher seat density also contribute to reducing carbon emissions per passenger as more passengers are carried in the same aircraft (Park and O'Kelly, 2014). As a consequence, the latest generations of aircrafts have seen dramatic improvements in their fuel efficiency, with a consumption of 2–3 L per seat over 100 km for the latest aircrafts, such as the A320neo, A330neo, A350 and B787 (Samunderu, 2019).

Regarding airlines, even if they are dependent upon the technological improvements made by manufacturers, they can adapt their operations to reduce their environmental footprints by using sustainable biofuels (Smith et al., 2017), implementing single-engine taxiing (Koudis et al., 2018), optimizing their trajectories and flight paths (Rosenow and Fricke, 2019) or developing carbon offsetting offers for passengers (McLennan et al., 2014).

Finally, while airports account for less than 5% of aviation emissions, many airports have taken initiatives to reduce their environmental footprint (Becken and Shuker, 2019). Benefiting from the institutional support of the Airports Council International (ACI), which uses a system of accreditations, various airports have tried to cut their emissions by optimizing taxiing procedures (Postorino et al., 2019), by offering alternatives to reduce the emissions of auxiliary power units (APUs) with the development of ground power units (GPUs) (Kilkis and Kilkis, 2016), or even by replacing existing lighting with LEDs (National Academies of Sciences, Engineering, and Medicine, 2019).

As pointed out by Becken and Pant (2019), most of these actions have a limited impact on carbon emissions and only cut carbon emissions by a few percent per action. However, the combination of all these actions taken by all the different types of participants contributed to significantly reducing aviation carbon emissions per passenger. Nevertheless, although only a few airlines have managed to reduce their carbon emissions in absolute value, most of the efforts made by the industry to curb its carbon emissions have not yielded sufficient results to compensate for the strong growth in air traffic.

One of the biggest challenges faced by the air transport industry regarding its environmental footprint comes from its future growth. Despite the likely temporary slowdown due to the COVID-19 pandemic (Tanrıverdi et al., 2020), air traffic is expected to keep growing strongly in the coming decades. While this strong growth is considered a positive outcome for airlines in terms of additional customers, it may also outweigh all their efforts to curb their carbon emissions (Sgouridis et al., 2011; Liu et al., 2020).

Nevertheless, in the remainder of this article, we focus our attention on current carbon emissions for three main reasons. First, all the paradigms or long-term forecast models used by the air transport industry are based on "business-as-usual" hypotheses, which can be strongly disturbed by important external events, such as the COVID-19 pandemic (Suau-Sanchez et al., 2020). As such, relying on these forecasts to investigate the future of air transport carbon emissions might be risky and lead to uncertain values. Second, as pointed out by Terrenoire et al. (2019), various scenarios of air transport growth and carbon emissions are based on the evolution of air traffic as well as the decisions made by airlines and governments. Accordingly, although we are able to precisely measure the current carbon emissions of air transport, we cannot measure future carbon emissions by air transport with the same level of certainty. Third, consistent with the previous argument, the uncertainty regarding the evolution of the aviation carbon emissions occurs along with additional uncertainty regarding the carbon emissions of other industries. Consequently, measuring the future contribution (in percentage) of air transport in terms of global carbon emissions appears to be very challenging because future aviation carbon emissions and future carbon emissions by other industries cannot be known.

2.3. Emergence of flygskam or flight shame in Europe

Despite the efforts made by all stakeholders in the air transport industry to reduce their environmental footprint, a new trend emerged in Europe at the end of 2017. Flygskam, which can be translated from Swedish as flight shame, is based on the underlying principle that many air trips that are made by passengers are not essential and can either be performed using a less carbon-intense transportation mode or simply replaced by a phone call or videoconference (Gössling et al., 2019). Therefore, it is not surprising that the word coined to characterize this phenomenon is a Swedish word. While Swedish people have strong environmental concerns, Airbus (2019) indicated that 2.35 air trips per capita were taken by Swedish people in 2018; thus, they fly 4 to 5 times as much as the average person (0.55 air trips per capita) and 50% more than the average European citizen (1.56 trips per capita). Therefore, their carbon footprint is much higher than that of people in other countries.

As explained by Flaherty and Holmes (2020) and Mkono (2020), this shame of flying has led to the development of strong buzz on social networks, which has been enhanced by the growing popularity of Greta Thunberg (Becken et al., in press). Using data collected by Socialert, we show that while the first tweet with #flygskam was posted in November 2017, more than 47,000 tweets had been posted by January 2020, and they have generated more than 880 million impressions on Twitter. As displayed in Fig. 1 below, the largest number of tweets mentioning #flygskam were published between April 2019 and October 2019, with a peak during Summer 2019.

While the flight shame phenomenon has had an important impact on social networks and benefited from extensive coverage in the news, its impact on air traffic remains quite uncertain. At first, flight shame may have impacted the perceptions or declarations of travelers. In that sense, a study conducted by UBS (2019) with 6000 respondents from the U.S., Germany, France and the U.K. revealed that 22% of respondents declared that they had reduced their number of flights (or tried to avoid flying) for environmental concerns in 2019. However, when we look at the actual air traffic statistics, the impact of flight shame differs from one country to another. Focusing on domestic air traffic (for which there exist alternatives to air transport), a decrease in air transport by 3.6% in 2018 and 9% occurred in Sweden in 2019 (Transport Styrelsen, 2018, 2019). The same trend appeared in Germany, with a decrease of 8.6% in domestic air traffic in the latest quarter of 2019 (ADV, 2019). In contrast, a recent analysis by Gössling et al. (2020) in Germany revealed that against a background of falling domestic air transport demand, respondents in their survey did not report a significant impact of flight shame on their travel behavior. This contradictory result is in line with France's domestic air traffic, which increased by 2.4% between 2018 and 2019 (DGAC, 2019). Therefore, the actual impact of flight shame in Europe remains uncertain, and the variations in terms of traffic must be carefully considered.

2.4. Investigating flygskam or flight shame through the lens of industry and organizational stigma

Whether it has an actual negative impact on traffic or not, growing public pressure associated with flight shame has forced several European governments to take measures to accelerate the environmental transition of airlines. For instance, Germany decided in 2019 to nearly double taxes on domestic flights to encourage consumers to travel by train on domestic routes. The same fiscal response has been adopted by France, which banned some domestic flights in 2020 for which relevant rail options were available. Facing serious threats to their economic viability and having to deal with decreases in popularity, airlines and the air transport industry as a whole have to react to this trend. This

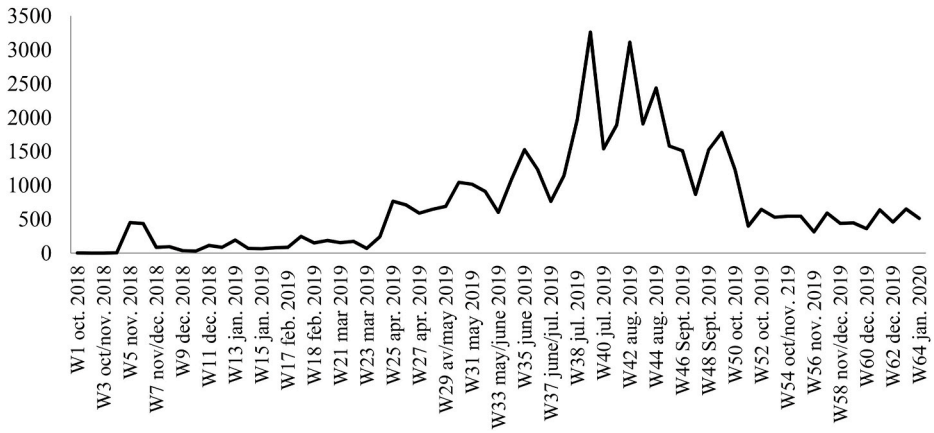

Fig. 1. Number of tweets using #flygskam from October 2018 to January 2020.

dangerous situation can be analyzed through the lens of industry or organizational stigma (Hudson, 2008). Devers et al. (2008, p. 157) defined organizational stigma as "*a label that evokes a collective stakeholder group-specific perception that an organization possesses a fundamental, deep-seated flaw that deindividuates and discredits the organization*". As noted by Vergne (2012), this stigma can be extended to an entire industry or product category (by opposition to an individual organization). Accordingly, industry stigma can be understood as a collective perception that an entire industry or the consumption of a category of products is flawed and contributes to discrediting the actions of the organizations operating in this industry and even their own existence (Zhang et al., 2020). Put differently, a central observation in the organizational stigma literature is that firms associated with a stigmatized category face an unusually high level of disapproval and see a lower engagement of their stakeholders (Vergne, 2012).

As explained by Hudson (2008) and Roulet (2020), firms facing such levels of disapproval need to understand how and why they are stigmatized in order to implement a strategy to cope with it. Vergne (2012) identified various strategies that stigmatized firms can implement to survive, from hiding their stigmatized activity to diluting the stigmatized activity within a larger portfolio of activities. In the specific case of air transport, one of the main difficulties for air transport executives is their own perception that the air transport industry has already made significant improvements in recent decades to reduce its environmental footprint. As a consequence, they do not understand why citizens and consumers feel ashamed when they fly, which increases the difficulty of implementing a strategy to deal with this stigma. Going beyond the strategies identified by Vergne (2012), Hampel and Tracey (2017) argue that some firms or industries are stigmatized because their stakeholders do not correctly perceive the intentions and practices of the stigmatized firm; therefore, such misperceptions must be corrected. This theoretical approach could be particularly relevant for investigating the flight shame phenomenon and the air transport industry's reactions.

As noted above, considering the recent trend of flight shame, a limited number of published research articles have investigated this phenomenon (Flaherty and Holmes, 2020; Gössling et al., 2020; Mkono, 2020; Becken et al., in press). While these articles have focused on characterizing this phenomenon, they have not always analyzed the roots or drivers of flight shame in detail, which is necessary information for airlines to determine how to react to this phenomenon.

In this research, we assume that flight shame may be caused by a lack of knowledge or "carbon literacy" regarding the actual environmental impact of air transport (Sharp and Wheeler, 2013; Howell, 2018). Previous research on the perception of the environmental impact of air transport by travelers has revealed that passengers tend to either underestimate or overestimate the challenges associated with global warming for the air transport industry (Becken, 2007; Mayer et al., 2012; Hagmann et al., 2015). Accordingly, we suggest that flight shame could be explained by a distorted perception of the environmental impact of air transport. Thus, in this research, we investigate the actual level of knowledge of the environmental footprint of air transport.

3. Methods

3.1. Research design

To investigate perceptions regarding the environmental impact of air transport, we conducted a survey assessing the awareness of citizens regarding the actual environmental footprint of air transport and its evolution (Levy and Lemeshow, 2013).

The survey is structured around four main questions starting from broad questions and then continuing to more precise questions (see Appendix 1). The first question addresses whether respondents are familiar with the share of air transport in global carbon emissions. The second question investigates how respondents think that carbon emissions per carried passenger have evolved over the last fifteen years. Focusing on technical progress made in recent decades, the third question examines whether respondents are familiar with the fuel efficiency of the latest generation of aircrafts. Finally, the fourth question investigates the respondents' awareness of the practices implemented by airlines to reduce their carbon footprint. For all of these questions (except question #4), different answers were provided (similar to a multiple-choice questionnaire), and respondents were asked to pick one answer among the different options.

3.2. Data collection and analysis

To investigate the perceptions of the environmental footprint of air transport, we focused our attention on France for five reasons. First, with almost 180 million air passengers carried in 2019 (DGAC, 2019), France is one of the largest air transport markets in Europe and has an established demand. Second, because of its extensive high-speed rail network powered by nuclear energy, France offers a considerable number of less carbon-intensive options instead of air transport for domestic trips. Rail options are clearly perceived as substitutes because every time a new high-speed line has been opened in France, the market share of air transport on these routes has plummeted (Chiambaretto, 2013). Third, France has always appeared in the top 5 countries, whether on Twitter or Google Trends, in terms of the number of tweets or search requests regarding flygskam, which indicates that the question of flight shame has become a key concern for many air transport consumers. Fourth, the French government has been one of the most active in terms of implementing measures to accelerate the environmental transition of airlines via the implementation of taxes or domestic flight bans, which has put

the air transport industry in this country at risk and forced the industry to react to this phenomenon. Finally, we admit to adopting a form of "methodical opportunism" (Girin, 2011) by collecting data based on the empirical opportunities and constraints provided to us. More precisely, because this research is being done by French researchers, it was easier for us to access French respondents.

To analyze these perceptions, we needed to collect data on a sample that was representative of the entire French population. In November 2019, we engaged a professional firm (Createst/Panelabs) specialized in collecting data with representative samples that are designed using the quota method (Fink, 2003). The quotas are based on gender, age, profession and geographical area in France. The respondents in the sample answered the survey online between November 21st and November 28th. The total sample size is 1018 respondents. Table 1 below details the composition of the target and actual sample following this method.

4. Findings

4.1. Comparison between the actual and perceived share of air transport in global carbon emissions

As explained in Section 2.1, although the noncarbon impact of air transport is still debated, there is a consensus among scholars regarding the contribution of air transport to global carbon emissions. Most scientists converge around a value that is between 2 and 3% of total carbon emissions. In addition to being consensual, this share has remained quite stable in recent decades so that there is a reasonable chance that people may have heard of it over the years. To assess the level of knowledge or literacy regarding the carbon impact of air transport, we asked the following question to our sample: "*According to you, what is the contribution of air transport to global carbon emissions?*" Fig. 2 (below) reveals that only 7% of the respondents (the dashed column) gave the correct answer, namely, 2–3% of global carbon emissions. Moreover, we find that 91% of respondents overestimate the actual share of air transport in carbon emissions, and 52% of respondents even think that the air transport industry accounts for more than 10% of carbon emissions.

This first result is interesting because it shows that a very large proportion of respondents (and thus of the French population) strongly overestimate the contribution of air transport to carbon emissions. With more than 50% of respondents believing that air transport accounts for more than 10% of carbon emissions, we can better understand why the aviation industry is often given as an example of a polluting industry that massively contributes to global warming.

4.2. Comparison between the actual and perceived evolution of carbon emissions per passenger carried over the last 15 years

Beyond the static approach we have adopted so far, it is important to investigate how consumers and citizens perceive the evolution of air transport carbon emissions over time. Because our sample is composed of French respondents, we use data provided by the DGAC (the French Civil Aviation Authority), which states that carbon emissions per carried passenger have decreased by approximately 25% over the last 15 years. To assess whether respondents realize the significant progress made to reduce carbon emissions per passenger, we asked the following question: "*According to you, over the last 15 years in France, would you say that carbon emissions per carried passenger have…*".

Strikingly, as shown in Fig. 3, only 2% of respondents (the dashed column) know the correct answer (i.e., carbon emissions per carried passenger have decreased by 25% over the last 15 years). Similarly, 98% of respondents underestimate the improvements made by the air transport industry to cut its unit carbon emissions, and 90% of respondents think carbon emissions per carried passenger have remained stable or even increased over the last 15 years in France.

Once again, it is worth highlighting that almost all of our respondents underestimate the efforts and improvements made by the air transport industry to reduce its carbon emissions per passenger. As a consequence, we better understand why many citizens argue that air transport is not doing enough to reduce its environmental footprint.

4.3. Comparison between the actual and perceived fuel efficiency of the latest generations of aircraft

Technological progress has been one of the main drivers for the reduction in air transport carbon emissions. As explained in Section 2.2, one of the main sources of progress comes from the improvement of aircraft fuel efficiency. For instance, the latest generations of aircraft, such as the A320neo, A330neo and B787, have reduced their fuel

Table 1
Target sample and actual sample compositions according to the quota method.

Criteria		Target N	Target %	Actual N	Actual %	Difference
Gender	Men	496	49.6%	500	49.1%	−0.5%
	Women	504	50.4%	518	50.9%	0.5%
		1000	100%	1018	100.0%	
Age	18-24 y.o.	133	13.3%	135	13.3%	0,0%
	25-34 y.o.	201	20.1%	207	20.3%	0.2%
	35-44 y.o.	214	21.4%	220	21.6%	0.2%
	45-54 y.o.	224	22.4%	230	22.6%	0.2%
	55-65 y.o.	228	22.8%	226	22.2%	−0.6%
		1000	100%	1018	100.0%	
Socio-professional category	Farmers, craftsmen, traders and business owners	52	5.2%	52	5.1%	−0,1%
	Executives, senior professionals	110	11.0%	112	11.0%	0,0%
	Intermediate professions	175	17.5%	178	17.5%	0,0%
	Employees and workers	376	37.6%	382	37.5%	−0,1%
	Retired	90	9.0%	94	9.2%	0.2%
	Inactive	197	19.7%	200	19.6%	−0,1%
		1000	100%	1018	100.0%	
Geographical area	Paris Area	190	19.0%	193	19.0%	0,0%
	Northwest	230	23.0%	234	23.0%	0,0%
	Northeast	230	23.0%	234	23.0%	0,0%
	Southwest	110	11.0%	112	11.0%	0,0%
	Southeast	240	24.0%	245	24.1%	0,1%
		1000	100%	1018	100.0%	

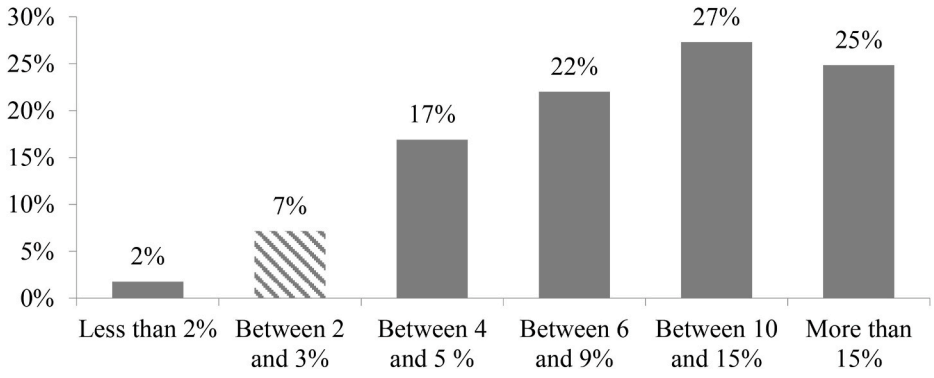

Fig. 2. Distribution of answers regarding the perceived share of air transport in global carbon emissions.

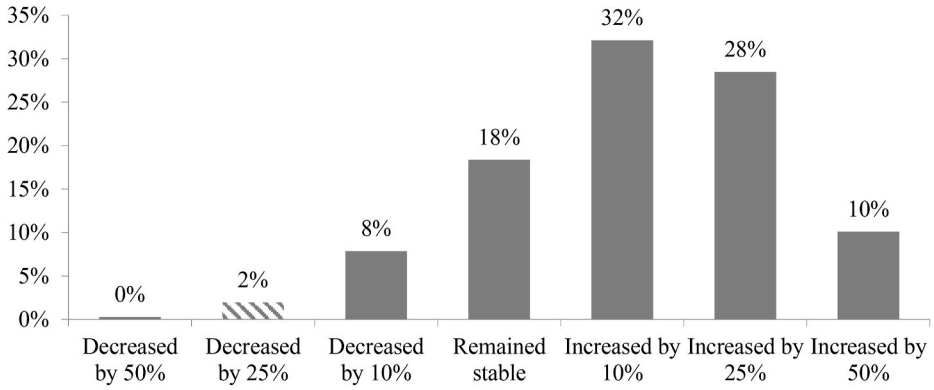

Fig. 3. Distribution of answers regarding the perceived evolution of air transport carbon emissions per passenger in France over the last 15 years.

consumption to approximately 2–3 L per passenger for every 100 km flown. However, citizens and consumers have not shown an awareness of these technological improvements. To address this technological aspect, we focus our attention on fuel efficiency (through consumption in liters per passenger for 100 km) because it is meaningful for French respondents due to their knowledge of their private car fuel consumption (expressed in liters for every 100 km as well). Accordingly, we asked the following question: "*According to you, what is the fuel consumption of the latest generations of aircraft (A320neo, A350, B787)?*" This question yields some very interesting findings that are summarized in Fig. 4.

First, 21% of respondents (i.e., the dashed column) answered correctly, which is much higher than the correct responses for the other questions. Interestingly, we note that 8% of respondents underestimate the fuel consumption of the latest generations of aircrafts and have an overoptimistic view of technological improvements. Moreover, we find that 71% of respondents overestimate the fuel consumption of the latest aircraft, with almost 25% of respondents indicating that they consumed more than 10 L per passenger for every 100 km flown.

For this question as well, we observe that a substantial share of respondents (71%) overestimate the fuel consumption of the newest aircrafts and minimize the technical progress achieved by aircraft manufacturers to reduce carbon emissions.

4.4. Assessment of the level of aided awareness regarding different measures to reduce air transport carbon emissions

While technical factors have played a key role in the reduction in carbon emissions, as explained in Section 2.2, other measures have been

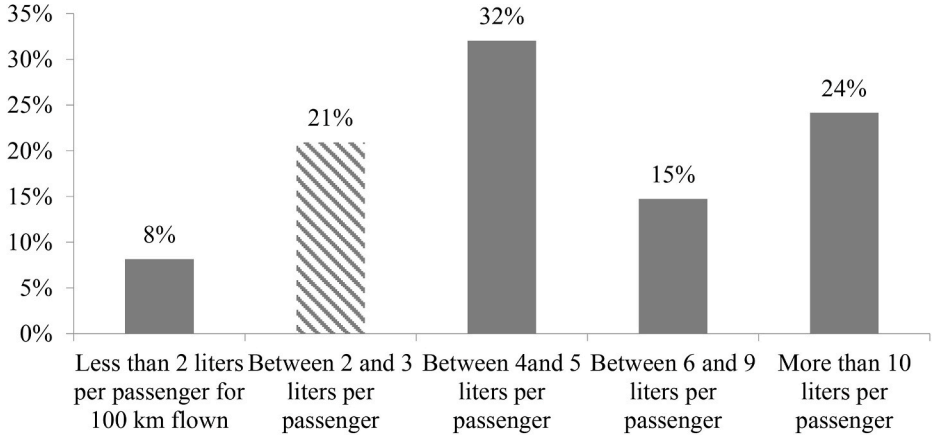

Fig. 4. Distribution of answers regarding the perceived fuel consumption of the latest generation of aircrafts.

taken by airlines and airports to limit the growth or cut carbon emissions. Nevertheless, the actual literacy or awareness of consumers and citizens regarding these different measures remains unknown. Accordingly, we measure the level of aided awareness for various carbon-cutting measures to highlight which measures are known or unknown by citizens and consumers. Fig. 5 shows the levels of aided awareness for several key measures.

Fig. 5 indicates that some measures to curb carbon emissions are better recognized than others. The most "famous" measure is the use of biofuels (dark gray in Fig. 5), with approximately 60% of respondents aware of the use of biofuels in the air transport industry. In addition, several measures have a level of aided awareness between 41% and 46% (gray in Fig. 5), and they include the use of composite materials (46%) and electric engines (46%) by aircraft manufacturers and the efforts made by airlines to optimize their trajectories (43%) while reducing the weight of their cabins (41%). Finally, the last two measures (white in Fig. 5) are completely ignored by respondents. Accordingly, only 11% of respondents are familiar with green taxiing or single-engine taxiing, and only 7% of respondents have ever heard of the CORSIA program implemented by the ICAO to limit the growth of carbon emissions at an institutional level. These results are in line with the global lack of knowledge of consumers and citizens regarding the environmental footprint of air transport as identified based on the previous questions.

5. Discussion and concluding remarks

5.1. Distorted perception of the air transport carbon footprint: lessons for the air transport industry

Our analysis indicates several issues regarding the perceptions of the environmental impact of air transport. From a static standpoint, we observe that a large proportion of respondents (91%) overestimate the contribution of air transport in global carbon emissions. The same misperceptions are observed from a dynamic perspective, with almost all respondents (98%) underestimating the reduction in unit carbon emissions that has been accomplished by airlines over the last 15 years. A potential explanation for these misperceptions may come from a lack of carbon literacy, a lack of knowledge of the actual technical progress (with 71% of respondents overestimating the fuel consumption of the latest aircraft) or a limited awareness of the different measures taken by the industry to reduce its carbon emissions.

In addition to pointing out these misperceptions, this research provides a number of factors that the air transport industry can focus on to address the flight shame phenomenon. As we explained earlier, the situation faced by the air transport industry can be assessed through the theoretical lens of industry or organizational stigma (Zhang et al., 2020). This theoretical perspective allows understanding how the criticism of the aviation industry for its environmental impact has led various stakeholders (from customers to governments) to limit the development of airlines. Because their existence and economic viability are questioned, airlines have to react and implement specific strategies to address this stigma (Vergne, 2012; Roulet, 2020).

Building on the work of Hampel and Tracey (2017) regarding destigmatization strategies, we argue that airlines and airports must adopt a strategy that consists of changing the negative perceptions of the industry as well as pursuing technical advancements. In that sense, destigmatizing means realigning the perceptions of the stakeholders with the reality of the practices implemented by airlines and airports. This may be accomplished by highlighting the misperceptions and emphasizing the efforts made by the airlines and airports to deal with their carbon emissions. A destigmatization strategy implies the adoption of a genuine educational approach to explain the technical measures that already exist in the industry and their effects on carbon emissions. As indicated by previous researchers, citizens usually have a low "carbon literacy" and do not know the extent to which their consumption of various products and services is related to their carbon emissions (Sharp and Wheeler, 2013; Howell, 2018).

This lack of knowledge is even more important regarding the carbon footprint of aviation (Becken, 2007; Mayer et al., 2012; Hagmann et al., 2015). Indeed, the air transport industry has adopted a very technical approach to the carbon emission problem and has not provided a comprehensive explanation of the associated measures and achievements to the general public. Accordingly, more communication is required to realign consumers' and citizens' perceptions with the reality of the environmental footprint of air transport. At the same time, as pointed out in a recent article by Hesse and Rünz (in press) investigating the "Fly Responsibly" campaign launched by KLM, airlines are often accused of greenwashing or of being deceptive when they communicate about their environmental actions. More precisely, many citizens do not understand what airlines have to gain when they take such carbon-reducing measures and thus remain very skeptical regarding the actual impact of these actions. As such, we argue that it is in the interest of airlines to be transparent in their communication and clearly state that reducing fuel consumption and carbon emissions is in their own economic interest because fuel expenses represent the first or second largest part of their costs. By adopting this transparent discourse, airlines may convince more skeptical stakeholders that they truly want to cut their carbon emissions, as it allows them to become more competitive.

Nevertheless, whether perceptions might be biased or not, airlines and airports cannot simply communicate their efforts because citizens are demanding that the industry pay more attention to the environmental footprint of air transport (Gössling et al., 2019, 2020; Flaherty and Holmes, 2020; Mkono, 2020). This growing pressure forces airlines

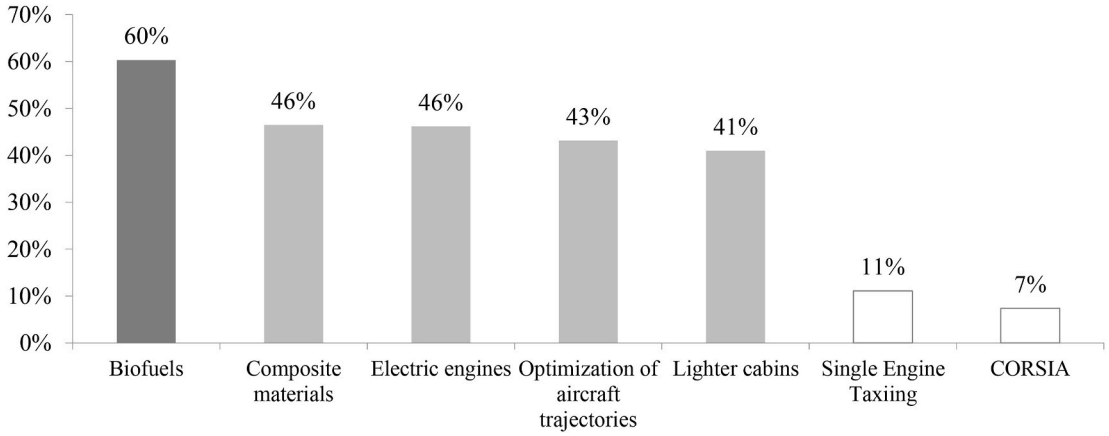

Fig. 5. Level of aided awareness regarding various implemented measures to reduce air transport carbon emissions.

and airports to adapt their strategies based on the expectations of their various stakeholders and to reduce their carbon emissions to a greater degree (Theodoulidis et al., 2017). A potential strategy may be to outperform these expectations and not only continue to reduce carbon emissions per passenger but also reduce them in absolute value (Becken and Shuker, 2019). To reach this objective, airlines and airports will need to be more ambitious regarding their existing environmental policies and will have to accelerate their environmental transition. Some airlines may even consider adapting their business models by fostering the development of intermodal air-rail strategies (Givoni and Banister, 2007; Chiambaretto and Decker, 2012).

5.2. Contributions to the literature

Our research makes three main contributions to the existing literature. First, we contribute to the growing literature that investigates the environmental impact of air transport. We show that while these contributions have focused on the actual environmental impact of this industry, the differences between the perceived and actual impact of air transport in terms of carbon emissions have been poorly considered. Our research fills this gap by emphasizing the extent to which citizens overestimate the air transport carbon footprint while underestimating the efforts made to reduce it. Moreover, we argue that more efforts should be made on improving the level of carbon literacy of citizens in general (Sharp and Wheeler, 2013; Howell, 2018) and for the aviation industry in particular (Becken, 2007; Mayer et al., 2012; Hagmann et al., 2015).

Second, we contribute to the emerging literature on flight shame by providing insights on the roots of this new phenomenon. While previous contributions aimed at defining and characterizing the phenomenon (Flaherty and Holmes, 2020; Gössling et al., 2020; Mkono, 2020; Becken et al., in press), our research reveals one of the drivers of this phenomenon. More precisely, we highlight how the lack of knowledge may create misperceptions of the environmental impact of air transport and thus a source of the misunderstanding that has led to the strong development of flight shame.

Finally, our research also contributes to the growing literature on industry and organizational stigma (Hudson, 2008; Vergne, 2012; Hampel and Tracey, 2017; Roulet, 2020; Zhang et al., 2020). We not only offer an empirical illustration of industry and organizational stigma with the air transport industry but also highlight an additional driver of these forms of stigma. More precisely, we show how a lack of knowledge of the organizations' practices can create misperceptions that can, in turn, generate some stigma. Consistent with the conclusions of Hampel and Tracey (2017), we highlight that stigmatized firms and industries must implement communication and educational strategies to realign perceptions and realities.

5.3. Limitations and directions for future research

Despite offering various insights into the roots of flight shame in Europe, this research suffers from several limitations that provide many directions for future research. The first limitation is based on our sample, which is composed of only French respondents. If a single-nationality sample is representative of the total population, then it may be interesting to replicate our analysis to other European countries to determine the external validity of our results beyond France. Furthermore, replicating this research in other countries would allow us to identify similarities or differences in terms of perceptions or knowledge regarding the environmental impact of air transport.

A second limitation stems from the absence of analysis between the distorted perceptions of respondents and their actual air transport behavior. Because this research remains exploratory, we invite future researchers to study in further detail the links between the misperception of the environmental impact of air transport and the actual travel behavior of respondents (Gössling et al., 2020).

A third limitation comes from the fact that most contributions on flight shame (including this one) have focused on the climate or aviation carbon footprint. However, although the origin of flight shame is clearly associated with climate change concerns, the social acceptance issues with aviation are not limited to these aspects and include noise or local air quality aspects (Dobruszkes and Efthymiou, 2020; Liebe et al., 2020). Accordingly, replicating this work with other indicators, such as noise or local air quality, could yield complementary insights.

A final limitation comes from the fact that our data were collected over a single period (in November 2019); thus, we cannot address how peoples' perceptions may have evolved over time. As the air transport industry has begun to counter the phenomenon via better communication on its environmental impact, it will be relevant to analyze whether peoples' perceptions change or remain the same after the communication campaigns.

Nevertheless, we remain confident that this research not only provides insights into the roots of flight shame in Europe but also lays the groundwork for more research on this new phenomenon that impacts the air transport industry.

Credit author statement

Paul Chiambaretto: Conceptualization; Methodology; Data Analysis; Writing – original draft; Supervision, **Elodie Mayenc:** Project administration; Data collection**;** Data curation, **Hervé Chappert:** Data collection; Data analysis, **Juliane Engsig:** Data collection, Data analysis**,** Visualization**, Anne-Sophie Fernandez:** Validation**,** Writing – review and editing**, Frédéric Le Roy:** Funding acquisition**,** Writing – review and editing

Declaration of competing interest

Some of the authors have interacted with airlines or airports on consultancy assignments or management training courses. Nevertheless, we are confident that these interactions did not contribute to any interpretation bias. Furthermore, we argue that none of the authors can derive any personal benefit from the publication of these results.

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Appendix 1. . Extract from the survey used for this research (*translated from French*)

This questionnaire is part of a non-commercial research project. The questionnaire is totally anonymous, and your answers will remain strictly confidential. The objective of this questionnaire (which should take between 3 and 5 min to complete) is to understand your perceptions of the environmental impact of air transport.

Only your personal opinion matters. You can answer this questionnaire whether you fly regularly or not, whether you prefer to take the train or not, etc. Do not try to find the answers to the questions on the internet because your perception at the time you answer this questionnaire is what is important.

Thank you for your participation!

Q1. According to you, what is the contribution of air transport to global carbon emissions?

- Less than 2%
- Between 2 and 3%
- Between 4 and 5%

- Between 6 and 9%
- Between 10 and 15%
- More than 15%

Q2. According to you, over the last 15 years in France, would you say that carbon emissions per carried passenger have…

- Decreased by 50%
- Decreased by 25%
- Decreased by 10%
- Remained stable
- Increased by 10%
- Increased by 25%
- Increased by 50%

Q3. According to you, what is the fuel consumption of the latest generation of aircrafts (A320neo, A350, B787)?

- Less than 2 L per passenger for 100 km flown
- Between 2 and 3 L per passenger for 100 km flown
- Between 4 and 5 L per passenger for 100 km flown
- Between 6 and 9 L per passenger for 100 km flown
- More than 10 L per passenger for 100 km flown

Q4. Have you heard of the following tools, policy and practices implemented by the air transport industry to reduce its environmental footprint? (*randomized order for the answers)*.

- Biofuels: YES/NO
- Composite materials: YES/NO
- Electric engines: YES/NO
- Optimization of aircraft trajectories: YES/NO
- Lighter cabins: YES/NO
- Single Engine Taxiing: YES/NO
- CORSIA: YES/NO

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