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Low-carbon travel mode choices: The role of time perceptions and familiarity

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ABSTRACT

Academic studies and recent social movements alike highlight the importance of changing flying behavior for reaching global climate goals. A particularly effective strategy for minimizing transport-related CO2 emissions is to substitute flights with train travel. The same trip causes around 80–90% less CO2 emissions by train than by plane. The results of this paper are based on two independent samples, the first representing the Swiss population, the second one including international business students. Both empirical studies consistently show that respondents who are familiar with train travel are also more prone to consider the train as an alternative for international, long-distance trips. Furthermore, both studies find systematic differences when it comes to travel time perceptions of likely air and train travelers: While people who are inclined to travel by plane see a high value in minimizing the total travel time of their journey, likely train travelers put less emphasis on minimizing total travel time. At the same time, prospective train travelers find it highly important to be able to use their travel time productively, which does not seem to be the case for potential air travelers. As consumer insights about the willingness to substitute flying with train travel are rare, the results of this paper build a basis for developing communication strategies and policies aiming at increasing low-carbon travel mode choices.

1. Introduction

Apart from a few shock events (e.g., the 1979 oil shock, the Gulf War, 9/11 or the global financial crisis in 2008/9), there has been a continuous growth in global air traffic passenger numbers since the 1950ies (Oxley and Jain, 2015). This global trend is expected to continue, with the rise of the middle class in emerging economies (Graham and Metz, 2017). Globally, passenger flight emissions account for 2–2.5% of global CO_2 emissions (Air Transport Action Group ATAG, 2019; REN21, 2019). While this global number may seem modest to some, passenger flight emission statistics for wealthy countries tend to change perspective. In Switzerland, a global leader in per capita flight emissions (Global Sustainable Tourism Dashboard, 2018), passenger flight emissions account for around 12–18% of national CO_2 emissions (WWF, 2015; Cousse and Wüstenhagen, 2019; Federal Council, 2020). Assuming the aviation sector's mitigation efforts remain less ambitious than other sectors, CO_2 emissions from passenger volumes could culminate in 22% of global CO_2 emissions by 2050 (Cames et al., 2015). The solution the world can rely on is twofold: technological innovations and behavior change towards low-carbon transport modes. Technological solutions such as the electrification of the aviation industry are on the rise (Roland Berger, 2017). Yet, it may take at least another decade before electric planes are ready for the commercial market (see, e.g., Kolirin, 2018). Also, historically, emissions growth from increasing passenger flight numbers has outpaced technological efficiency gains (Peeters et al., 2016). Thus, behavior change is central, but may be contingent on relative price increases of plane tickets, and changing social norms. In the past one to two decades, low-cost carriers have been responsible for a large part of growth

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in air travel demand (Rey et al., 2011; Abda et al., 2012; Dobruszkes and Mondou, 2013; Tsui, 2017). Current political discussions in several countries (e.g., Switzerland and Germany) on the introduction of CO_2 taxes on flight tickets aim at increasing flight relatively to train ticket prices. As for changing social norms, two diverging tendencies are observable. Frequent flyer and hypermobile lifestyles (Shaw and Thomas, 2006; Becken, 2007; Cohen and Gössling, 2015; Cohen et al., 2018) accelerate air travel growth. Contrarily, the "flying shame" movement (e.g., #flygskam) has led to decreasing flight passenger numbers in Sweden since 2017 (Hoikkala and Magnussen, 2019). In addition, a study by the Worldwide Fund For Nature shows that, in 2018, 18% of Swedes chose train over air travel (Hoikkala and Magnussen, 2019). Substituting flights with train travel can significantly reduce transport-related CO_2 emissions as a train trip can save around 80–90% of CO_2 emissions compared to the same trip with a flight.[1]

In addition to the Swedish example, several academic studies (e.g., Hares et al., 2010; Cohen et al., 2011) highlight the importance of investigating to what extent changing behavior towards low-carbon substitutes is a possible solution to limit CO_2 emissions from air travel.

While past research shows that a shift from air to high-speed rail travel is possible (e.g., Albalate et al., 2015; Gundelfinger-Casar and Coto-Millán, 2017), studies that shed light on the role of social and psychological aspects of behavior change towards international railway travel are relatively limited. This paper contributes to this research gap by addressing the following research questions:

1) To what extent do consumers consider train trips as a viable alternative to flights?
2) How do time perceptions affect travel mode preferences?
3) How does familiarity with train travel affect travel mode preferences?

Methodologically, this paper draws on two different primary data sets from two complementary studies to better comprehend the drivers of low-carbon travel mode choices. Both studies rely on highly relevant samples for the research at hand as they consist of frequent, international travelers.

Study 1 is based on a representative survey ($N = 1021$). Study 2 consists of a field-based intervention study, including data on stated and revealed preferences from an independent sample of international business students ($N = 50$). Thereby, in both studies, respondents were asked about their preferences for substituting air with long-distance train travel for distances of 300 km or longer.[2] As such, both studies differentiate between two main groups: likely train travelers and likely air travelers. The former consider the train to be a viable option compared to the flight, whereas the latter are unlikely to do so. In Study 1, train travel consideration applies to a hypothetical setting, while in Study 2, to a real-life decision-making context.

Based on results from the two studies, practical implications will be proposed, both for railway operators looking for ways to increase their customer base, as well as for policymakers to foster behavior change towards low-carbon travel options. From an academic point of view, this paper contributes to the literature on the barriers to and persuaders of sustainable long-distance travel mode choices and behavior change. Sussman et al. (2020) identify this to be a key gap in the literature on behavioral aspects of modal choice.

In the following, Section 2 builds on relevant literature on the drivers of international, long-distance travel mode choices to formulate hypotheses. Section 3 presents the data, methods and results of the large-scale survey. The content of Section 4 focuses on the data, methods and results of the intervention study that investigated real travel behavior in a longitudinal setting. Section 5 discusses the overall results and relates them back to extant literature. Section 6 concludes this paper with main insights and derives implications for policymaking and railway operators.

2. Literature review and hypotheses

2.1. Modal choice: Plane vs. Train

One central literature stream for understanding why people choose the train over the plane focuses on the substitution effect of high-speed rail on air transport. Within this particular research field, several studies find travel time to be the most important criterion for choosing the train over other alternative travel modes (Steer Davis Gleave, 2006; Cascetta et al., 2011; European Commission, 2010; Behrens and Pels, 2012; Sun et al., 2017). Further aspects that are often found to be a relative advantage of high-speed rail are service frequency and access time (Bieger and Laesser, 2001; Behrens and Pels, 2012). Some studies such as the one by Bieger and Laesser (2004) look into a broad number of possible attributes as drivers of choice between train travel and flying. More specifically, Bieger and Laesser (2004) discover that the most important determinants of modal choices, in the context of the market entry of low-cost airlines in Switzerland, are travel time, flexibility, comfort, travel cost and safety. Thereby, the preference for air travel, in general, is driven by perceived travel time and comfort (Bieger and Laesser, 2004). Low-cost airline offers are found to be a good option for time-sensitive travelers, under the condition that these

[1] In some cases, the train saves even more emissions compared to the flight. See, for example, Zurich-Paris on http://ecopassenger.org. While CO_2 emissions per passenger kilometer can vary (e.g., due to a country's electricity mix), the ongoing decarbonization of electricity systems will allow for very low CO_2 emissions per passenger kilometer to apply more generally (Sims et al., 2014). To date, three-quarters of passenger rail transportation is electrified (IEA, 2019).

[2] This long-distance train travel definition would correspond to approx. a 1 to 1 h 15 min flight: A 300km railway distance such as Zurich-Frankfurt (308km in terms of air distance) would equate with a 1-hour flight. A somewhat longer railway route in terms of km would be Zurich-Paris (489km in terms of air distance), which would correspond to a 1h 15 min flight. (Source for train travel routes in km: www.luftlinie.org).

offers include short transfer times and convenient inter-modal exchange (Bieger and Laesser, 2004). Costs, familiarity[3] and sustainable behavior determine the preference for the train (Bieger and Laesser, 2004).

2.2. Travel time perceptions

2.2.1. Perceptions of travel time: Productive travel time vs. total travel time

Cost-benefit analysis is a common approach to transport policy design. As pointed out by Mokhtarian and Salomon (2001), Lyons and Urry (2005) and Jain and Lyons (2008), these analyses (e.g., Mackie et al., 2001) mainly assume time to be an opportunity cost of a trip and are based on the rationale that travel time is unproductive. To some extent, these models acknowledge that travel time can be used for work purposes (Fowkes, 2001). Contrarily, Jain and Lyons (2008) propose that travel time may have an intrinsic value and diverges from the mere monetary assessment of time as cost. The authors highlight that subjective experiences and context influence perceived travel time utility (Jain and Lyons, 2008). Also, Lyons and Urry (2005) suggest that travel time can be productive and may lead to a rethinking of traditional appraisal methods, especially in the information age (see also Mokhtarian and Salomon, 2001; Wardman and Lyons, 2016).

A further aspect to consider is that the travel time utility also depends on the travel purpose and the travel mode. For example, in a business context traveling tends to be more time-sensitive compared to travel for leisure purposes (Mackie et al., 2001). As for the differences in travel modes, Lyons and Urry (2005) propose that travel time utility can be higher for public transportation modes as opposed to car travel. Further, LaMondia et al. (2016) suggest that automated vehicles may cause shifts in modal choices due to benefits from hands-free travel. As such, Wardman and Lyons (2016) propose that the possibilities provided by the digital age have the potential to revolutionize existing travel modes as they generally increase the benefits of travel time. While this is already the case today, Wardman and Lyons (2016) expect this trend to continue (e.g., with product innovation or the increasing flexibility of where and when business and social practices take place).

The studies above highlight that travel time perceptions will likely vary between travelers and may be one of the critical drivers for travel mode decision-making. It is expected that likely air travelers will find the minimization of total travel time to be more important than likely train travelers. The latter are expected to see a higher value in travel time productivity than likely air travelers.

H1. *Likely air travelers are more concerned with minimizing travel time and are less concerned about travel time productivity than likely train travelers.*

2.2.2. The reference point for making travel time comparisons

Considering the discrepancies between travel time perceptions, there is a need to better understand how people make comparisons between flight and train travel times. Previous research acknowledges that it is important to account for access time (i.e., time to get to and from a railway station or airport) and the quality of travel time (i.e., number of transfers) (Givoni and Dobruszkes, 2013). However, to the author's knowledge, previous studies have not looked into how people actually compare the travel time of competing travel mode options. When calculating the travel time for a given route, rational choice models would suggest that comparisons between train and air travel are made on the basis of the same departure and arrival points. In this respect, in terms of total travel time and particularly net travel time, planes tend to have a relative advantage as opposed to trains as they are often the faster mode when it comes to international, long-distance travel. In this paper, the total travel time corresponds to the door-to-door calculation of the time spent for the plane/train trip, net travel time$_1$ refers to in-vehicle travel time and net travel time$_2$ to in-vehicle plus additional retention time at airports/train stations (e.g., check-in/check-out). Productive travel time indicates the travel time used for work purposes. If one calculates air travel time on a door-to-door basis (e.g., the city center of Zurich to the city center of Paris),[4] it can be similar to the total train travel time.[5] In addition, when traveling from Zurich to Paris, train travel time may have a higher utility thanks to a direct train connection (4 h 17 min) as opposed to the flight, where the net travel time$_1$ is 1 h 15 min and transfer and retention time result in (at least) 2 h 25 min. One possible source of bias when calculating the actual door-to-door travel time is the ticket booking process, where in most cases net travel times of a given travel mode and not door-to-door travel times are indicated (Sauter-Servaes et al., 2019). It is probable that the information provided on booking platforms is used as the starting point to compare calculations of travel time and thus, may have an anchoring effect on judgment (see Tversky and Kahneman, 1974). In the case of flight ticket booking platforms, flight times correspond to the travel time between takeoff and landing (net flight travel time$_1$) without accounting for access time, check-in and baggage claim. Contrarily, indicated train travel times correspond to the time needed to get from one city center to the next (net train travel time$_1$). Given these considerations, the following hypothesis is tested.

H2. *Comparisons between the travel time of the flight and the train trip are not made based on the total travel time of the flight and train trip, but rather on the net travel time.*

[3] In this context, familiarity means that people are more familiar with daytime trains than they are with (low-cost) air travel (Bieger and Laesser, 2004).

[4] Zurich-Paris by plane: total travel time = 3h 40 min; total travel time was calculated as follows: 10min (transfer from Zurich Main Station – Zurich Airport) +1h 30min (check-in/check-out) + 1h 15min (flight time between departure and landing = net travel time$_1$) + 45min (Paris Charles de Gaulle Airport – Paris Gare de Lyon) = 3h 40 min. (Source: Own calculations based on google.com/maps and google.com/flights).

[5] Zurich-Paris by train (direct route): total travel time = net travel time = productive travel time = 4h 17 min. (Sources: SBB.ch, google.com/maps, SNCF.com).

2.3. Familiarity with train travel

The theory of planned behavior proposes that social behavior is reasoned as attitudes, subjective norms and perceptions of behavioral control are guided by beliefs, which result in intentions and ultimately action (Ajzen, 1991). The rational nature of this model has been challenged by a distinct stream of literature suggesting that measures of habit can be better predictors of behavior (e.g., Triandis, 1977; Verplanken et al., 1997). Habits are distinct from other behaviors in that they are repetitive, automatic and goal-oriented (Bargh, 1989). In line with the findings by Verplanken et al. (1997), Kenyon and Lyons (2003) show that the majority of travelers make automatic and habitual mode choices and that they may be unaware of viable alternative travel modes as they only rarely consult information about substitutes. Following this logic, people who have a habit of flying may be less likely to seek information about long-distance train travel.

In the context of train and air travel, Bieger and Laesser (2004) discover that the strength of a familiarity effect may lead to relative advantages for travel modes that people are familiar with. When comparing different travel modes to get from Zurich to Berlin and Freiburg to Leipzig, the authors find that familiarity and sympathy towards travel modes have the most significant positive effect on daytime train connections (Bieger and Laesser, 2004). As the study by Bieger and Laesser was conducted when low-cost airline offers were less ubiquitous than today, train travel may no longer have a relative advantage to air travel. Instead, the growth in demand for flights could be a result of the fact that taking the plane has become the obvious first best option for the general public. Compared to flights, train travel may still have an advantage when it comes to the familiarity effect. People who use public transportation are also more likely to be more familiar with train travel. Against this backdrop, the following hypothesis investigates the effect of familiarity with public transportation on the consideration of long-distance train travel.

H3. *Familiarity with train travel in a general sense (*e.g.*, public transportation use, ownership of travelcards) leads to a higher possibility of considering taking the train instead of a plane.*

Study 2 is based on a field intervention and has the aim of exploring the role of familiarity with international, long-distance train travel. Research on breaking flying habits and fostering low-carbon, long-distance travel modes remain an understudied research area (Sussman et al., 2020). Therefore, the following hypotheses draw on insights from research that investigates strategies to break car habits and foster public transportation use.

In their study, Kenyon and Lyons (2003) investigate the role of information for modal changes. They find that information provision about alternative travel mode options in response to a single journey inquiry can challenge existing perceptions about the dominant mode and disrupt habitual travel choices. Experience, which is closely linked to habit and attitudes, seems to play an important role as well (Kenyon and Lyons, 2003). Without experience, assumptions inform attitudes about public transportation (Kenyon and Lyons, 2003). Inexperienced public transportation users tended to be unfamiliar with information sources and thus associated a higher planning effort and forethought with public transportation use, whereas car travel appeared psychologically more comfortable (Kenyon and Lyons, 2003). The authors also found a correlation between low experience and negative attitudes towards public transportation, based on which they suggest that actual experience could potentially remove an important barrier to increasing public transportation use.

Following these insights, the information about long-distance train travel options and the train travel experience itself is expected to remove the barrier to long-distance train travel, particularly for inexperienced train travelers. In contrast, the students who have been traveling long-distance by train on a regular basis prior to the field intervention should already feel more at ease with long-distance train travel. As such, the latter are expected to have higher intentions to travel by train from the outset, while occasional train travelers will likely be more affected by the intervention.

H4. *The increase in intentions to travel by train in the future will be more pronounced for the case of inexperienced long-distance train travelers than for regular train travelers.*

Trialability is one of the five attributes of an innovation which, according to Rogers (2010), accelerate diffusion. Trial experience as a key soft measure to behavior change has also been the main assumption underlying studies that have used free public transportation passes to break car habits. In this context, previous research has tested the effectiveness of offering a free one-month travelcard on attitudes toward public transportation and on breaking car habits (see Fujii and Kitamura, 2003; Thøgersen and Møller, 2008). Following these studies, hypothesis 5 investigates the effect of becoming familiar with international, long-distance rail travel on future intentions.

H5. *Long-distance train travel experience increases intentions to travel by train in the future.*

3. Study 1: Representative survey

3.1. Survey and sample

Data was collected in April 2019 through a representative survey (see Table 1) on consumer preferences and perceptions on renewable energies, mobility and climate policy in Switzerland (N = 1021). Given the timeliness of the topic, several questions focused on travel mode choices. Respondents were recruited from a Swiss online consumer panel through a professional market research company.[6]

The Swiss case is particularly interesting for studying behavior change towards long-distance travel: Geographically, Switzerland is located in the heart of Europe and many destinations are easily accessible by trains as well as planes. Also, the Swiss railway system has been rated as number one in Europe thanks to its intensity of use,[7] primarily driven by passenger traffic (Duranton et al., 2017). Thus, the Swiss tend to be more familiar with train travel than other populations, but at the same time are rather frequent flyers, as pointed out in Section 1 (see Global Sustainable Tourism Dashboard, 2018).

Table 1
Study 1, demographic characteristics of the sample.

Variables		Sample (N = 1021)[c]	Swiss Population[c,d]
Gender	Female	51%	51%
	Male	49%	49%
Age[a]	15–19	6%	6%
	20–29	16%	15%
	30–44	25%	25%
	45–59	26%	27%
	60+	27%	26%
Region (excl. Ticino)	Western Switzerl. (French-speaking)	25%	25%
	Alps & Prealps	24%	24%
	Swiss Plateau West	22%	22%
	Swiss Plateau East	29%	29%
Political Attitude[b]	Right-wing	45%	51%
	Center	27%	23%
	Left-wing	21%	27%
Education	Low/medium	58%	56%
	High	42%	44%

[a] People below 15 years old are not included in the sample. Therefore, the averages for the Swiss population were adjusted to meet the sampling criteria.

[b] For the analysis at hand, the seven political parties represented in the national parliament were grouped into three main categories: right-wing (SVP, FDP), center (CVP, BDP, GLP) and left-wing (SP, Green). 7% of respondents indicated "other/no party".

[c] Chi-square test results revealed that there are no statistically significant differences between the sample in Study 1 and the Swiss population data.

[d] Data sources: Age, gender and education data are drawn from the Swiss Federal Office of Statistics (2018a). Region data is based on Swiss Federal Office of Statistics (2018b). For political attitudes the seating distribution of the Swiss national parliament was used as a data source (Swiss Parliament, 2019).

3.2. Measures

3.2.1. Consideration of taking the train as a viable alternative to the plane

The survey included questions about whether respondents consider the train as a viable alternative option when traveling long-distance (>300 km) within Europe (e.g., Zurich-Paris/Zurich-Frankfurt). The aim was to measure more general preferences as opposed to measuring the preference of one specific travel route. To maintain the comparability of the results, the reference points (Zurich-Paris/Zurich-Frankfurt) were included. Respondents were asked to indicate whether they perceived the train trip as a viable alternative to the flight for their business and private travels respectively. This question was asked on a seven-point scale with "do not agree" vs. "agree" at the two extremes with no other indication on the scale. Moreover, it included an option to indicate that someone does not travel long-distance within Europe for business or private purposes.

3.2.2. The relative importance of time perception

As a follow-up to the previous question, respondents were clustered into two groups, likely train travelers and unlikely train travelers, based on whether they regard the train to be a viable option (5–7 on the seven-point scale) or not (1–3). Both groups were asked to indicate the relevance of several reasons (seven-point scale) for their respective preferences (see Table 2). Most criteria presented to respondents were derived from literature on modal choice generally and between train and plane more specifically. Further reasons were added to explore newly emerging trends in a time of changing social norms at the societal level and to bring novelty into existing literature.

[6] The panel consists of 100′000 registered Swiss individuals who have been actively recruited through Intervista. https://www.intervista.ch/panel/.

[7] Duranton et al. (2017) measure intensity of use by means of passenger and goods volume (i.e., extent to which rail transportation is used by passengers and freight companies) whereby they define passenger volume as the number of passengers multiplied by kilometers traveled divided by a country's population.

Table 2
Criteria for modal choice between air and train travel.

Sub-samples	Modal choice criteria	Literature streams	Academic articles	Emerging trends & newspaper articles
Business & private travelers	Travel time	Modal choice; competition of aviation & HSR	Bieger and Laesser, 2004; Steer Davis Gleave, 2006; Cascetta et al., 2011; European Commission, 2010; Behrens and Pels, 2012	
	Travel cost	Modal choice; competition of aviation & HSR	Bieger and Laesser, 2001; Steer Davis Gleave 2006; European Commission, 2010; Steer Davis Gleave, 2016	
	CO_2 emissions	Modal choice & ecological concern	Hares et al., 2010; Cohen et al., 2011; Higham et al., 2016	Changing social norms at the societal level & flying shame (e.g., Hoikkala and Magnussen, 2019; Wilkes and Weiss, 2019).
	Low complexity of the train/flight ticket booking process	Information access; ease of online ticket booking processes	Cheng and Huang, 2014; Dedeke, 2016	
	Punctuality of the train/flight	Modal choice; competition of aviation & HSR	Bieger and Laesser, 2001; Steer Davis Gleave, 2016.	
	Other reasons			
Additional reasons for business travelers	Possibility to work during the train trip/flight	Travel time utility	Fowkes, 2001; Mokhtarian and Salomon, 2001; Lyons and Urry, 2005; Jain and Lyons, 2008; Wardman and Lyons, 2016.	
	Active support of train travel/flight by my company	Modal choice & corporate travel policies	Cohen et al., 2018	Climate friendly corporate travel policies (e.g, Ro, 2019)
Additional reasons for business/private air travelers	Earn miles	Customer value of air travel	Bieger et al., 2007	
	I have never considered the train as an alternative option to the plane.	Habit & the role of information	Kenyon and Lyons, 2003	

3.2.3. Familiarity with train travel

Apart from the measures of travel time and productive travel time, respondents were asked to indicate how often they use public transportation on a five-point scale (1 = once a day, 2 = once a week, 3 = once a month, 4 = once a year, 5 = never). For the subsequent data analysis, public transportation users are coded as infrequent (1 = once a year; never), moderate (2 = once a month) and frequent (3 = once a week, once a day) users.

The frequency of public transportation use may depend on a respondent's specific commute. Thus, in addition to the "frequency of public transportation use", respondents were asked whether they own (1) no travelcard, (2) a GA travelcard[8] (3) a half fare travelcard, (4) a half fare travelcard in addition to a point-to-point travelcard, (5) a point-to-point travelcard (and no half fare travelcard), (6) any other kind of travelcard. This categorization allows measuring the familiarity with public transportation use in more general terms. It also comes closer to a measure of habit, as people who have a travelcard are automatically more compelled and inclined to use public transportation in general without thinking about alternatives.

3.3. Data analysis and results

3.3.1. Considering the train as an alternative option

Out of the total sample (N = 1021), 91% (N = 932) of respondents indicated that they travel long-distance within Europe for private purposes, while 9% (N = 89) do not. Of these 932 private travelers, 18% (N = 170) did not view the train as a viable option for their private trips (scale points 1–3), while those who did (scale points 5–7) made up 71% (N = 658). 11% of respondents (N = 104) were unsure (scale point 4) as to whether they consider the train as a viable alternative and were not included in the further analysis.

50% (N = 508) of the overall respondents indicated that they go on business trips. Thereof, 67% (N = 340) consider the train as a viable option, whereas 21% (N = 106) do not. The remaining 12% were unsure about train travel being a viable option (N = 62).

These first insights show that a clear majority of business (67%) and private travelers (71%) are likely train travelers as they (rather) consider the train as an alternative option for their long-distance travels (>300 km) within Europe.

3.3.2. Time perceptions: Travel time and travel time productivity

The descriptive results shown in Fig. 1 give a first indication that people who consider the train as a viable option have very different perceptions about relevant reasons for travel mode choices as opposed to people who always choose to fly. While likely train travelers see manifold benefits of the train trip, likely air travelers mainly have three reasons for their preferred travel mode: total travel time, travel cost and punctuality.

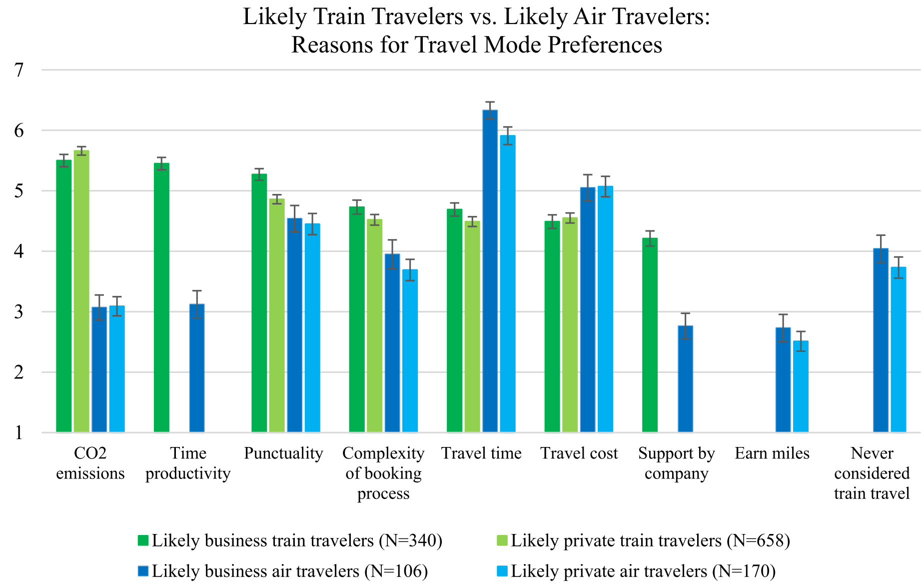

Fig. 1. Reasons for considering the train as a viable option vs. not a viable option.

[8] A GA travelcard allows for unlimited travel on the Swiss national railways (SBB) and on most other public transportation routes. (Source: https://www.sbb.ch/en/travelcards-and-tickets/railpasses/ga.html).

In addition to the descriptive results, a one-way ANOVA[9] shows that the differences between likely train and air travelers are, in all cases, statistically significant for private and business travelers (see Appendix A). Likely train travelers find the following reasons to be significantly more important compared to likely air travelers[10]: CO_2 emissions, travel time productivity*, the punctuality of the travel mode, low complexity of the booking process, and the preferred travel mode being actively supported by their company*. Contrarily, likely air travelers mainly find total travel time but also travel cost to be significantly more relevant as opposed to likely train travelers.

For business travelers, the difference in perceptions is particularly pronounced in the case of travel time productivity. Likely train travelers find travel time productivity to be relevant. At the same time, likely air travelers find travel time productivity not only to be significantly less relevant than likely train travelers, but also rather irrelevant as such. These results show support for H1, suggesting that travel time valuations may have an effect on mode choice between the train and plane.

A further noteworthy result concerns the mean for "never having considered the train as an alternative option" as it is slightly above 4 for business and slightly below 4 for private air travelers. This implies that likely private air travelers have a weaker flying habit and may be somewhat more aware of the option to take the train.

3.3.3. Familiarity with train travel

The effect of both familiarity measures ("public transportation use" and "ownership of a travelcard") on the consideration of train travel was investigated using multiple one-way ANOVA.

3.3.3.1. Frequency of public transportation use and consideration of long-distance train travel. Fig. 2 illustrates the effect of frequency of public transportation use on the consideration of long-distance train travel (see Appendix B).[11] Both one-way ANOVA show significant effects for the frequency of public transportation use on the consideration of long-distance train travel for private and business travelers. Pairwise comparisons between the three groups, frequent, moderate and infrequent public transportation users, provide more detailed insights (see Appendix C). For the case of private travelers, the Games-Howell post-hoc analysis revealed statistically significant differences between all three groups, although at different p-values. The mean level of consideration increased from infrequent to moderate public transportation users, from moderate to frequent users and from infrequent to frequent users. For the case of business travelers, the three groups vary to a lesser extent. The Games-Howell post-hoc analysis only showed statistically significant differences between frequent and infrequent public transportation users.

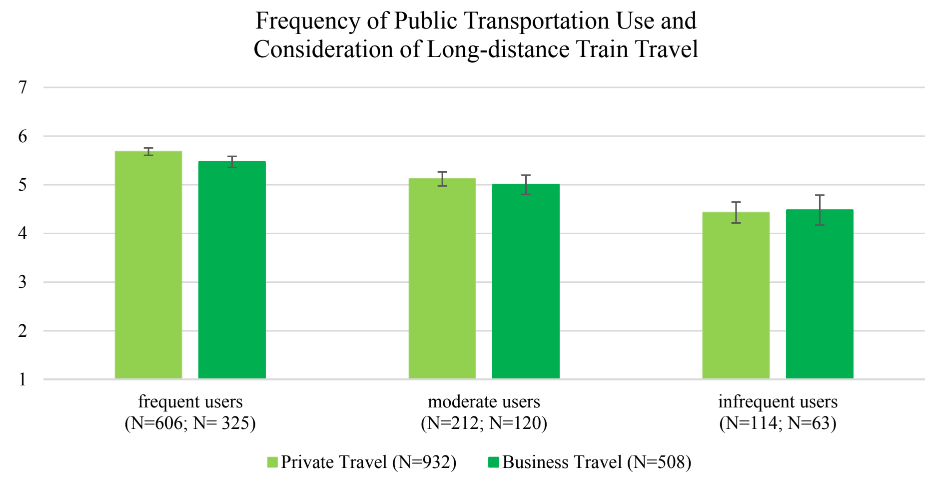

Fig. 2. Long-distance train travel consideration levels for frequent, moderate and infrequent public transportation users.

3.3.3.2. Ownership of a travelcard and consideration of long-distance train travel. Fig. 3 illustrates the effect of owning different types of travelcard subscriptions on the consideration of long-distance train travel.[12] Also for this measure, one-way ANOVA resulted in

[9] Given that the group sizes of people who consider the train (likely business train travelers: N = 340; likely private train travelers: N = 658) are larger than the group sizes of people who do not consider the train as a viable option (likely business air travelers: N = 106; likely private air travelers: N = 170), the test of homogeneity of variances turned out to be significant for all tested reasons except for company support (p = 0.6) and travel cost (p = 0.281). For these reasons, the results from the robust test of equality of means (Welch's test) are reported here.

[10] Reasons that only apply to business travelers are marked with *.

[11] The test of homogeneity of variances turned out to be significant for the consideration of train travel for business and private purposes. Thus, robust test of equality of means (Welch's test) as well as Games-Howell post-hoc test results are reported.

[12] The test of homogeneity of variances turned out to be significant for the consideration of train travel for business and private purposes. Thus, robust test of equality of means (Welch's test) as well as Games-Howell post-hoc test results are reported.

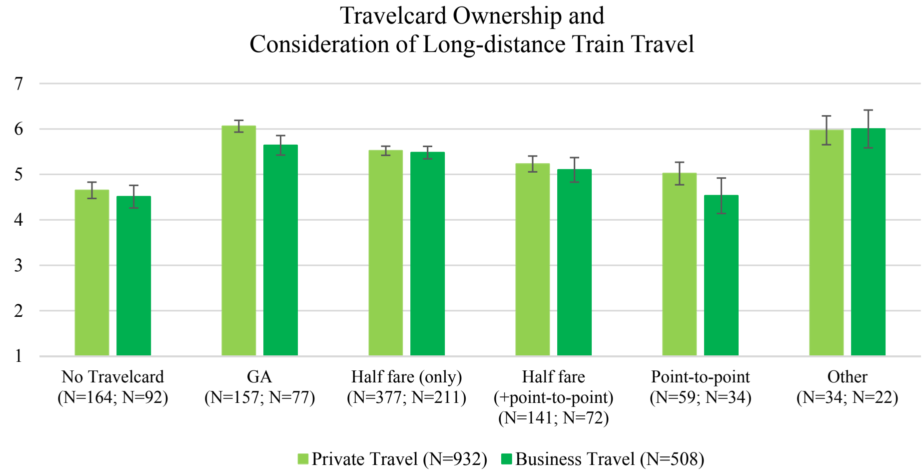

Fig. 3. Long-distance train travel consideration levels for different types of travelcards.

statistically significant effects on the consideration of long-distance train travel for private and business travelers (see Appendix D). According to results of the Games-Howell post-hoc analysis (see Appendix E), private as well as business travelers who do not have a travelcard reveal a significantly lower consideration of long-distance train travel than respondents with a GA, a half fare (without an additional subscription) and another type of travelcard. Business and private travelers who only own a point-to-point travelcard reveal relatively low levels of consideration of long-distance train travel. As the large majority of this group, 97% (N = 57) of private and 94% (N = 32) of business travelers, also indicated that they use public transportation frequently, this may suggest that this group limits its public transportation use to specific commutes.

These results confirm H3 as they suggest that familiarity with train travel in general terms is linked to higher levels of long-distance train travel consideration. For one, the frequency of public transportation leads to a higher likelihood of long-distance train travel consideration. Secondly, particularly people who own a travelcard that is generally valid for the national railway system (i.e., GA or half fare cards) are also more likely to consider long-distance train trips. This is not the case for people who own a travelcard that is limited to a specific commute (i.e., point-to-point travelcards).

4. Study 2: Intervention study

4.1. Survey, intervention and sample

Study 1 has shown that familiarity and time perceptions correlate with stated travel mode preferences. Will these preferences hold in a real-life decision-making context? To answer this question, Study 2 consists of a field-based intervention study with international business students (N = 50) traveling long-distance (see Appendix F for a comparison of the samples used in Study 1 and Study 2). International business students are an important sample for studying modal choice as they are likely to travel relatively frequently for their careers. Also, they may take on influential roles in the future.[13] Participants of the intervention study included students of a master's course offered in parallel at nine universities[14] followed by a two-day Model UNFCCC.[15] Thus, after attending a coordinated, semester long course on climate science, international policymaking and economics at their local universities, students from eight universities traveled to the University of Cologne for a simulation of the United Nations' climate policy negotiations.

Study 2 is based on a panel design including two waves. The first online survey (t_0, $n = 102$) was sent out at the beginning of the course (February-March 2019) and the second one (t_1, $n = 59$)[16] three weeks after the 2-day role-play (June 2019). The drop-out rate was 42%. The final sample (N = 48)[17] consisted of students aged 20–29. 50% were male and 50% female students. The intervention took place between the two waves and consisted of an offer of *low-carbon travel grants*, a monetary incentive that was only provided to students if they chose to travel by train to Cologne. Students were informed about the travel grants in class by their professors who coordinated travel arrangements with their students. For reasons of perceived distributive justice among students, the amount of

[13] For information on CEMS Alumni see: http://www.cemsalumni.org/news/facts-figures/.

[14] These nine universities are all part of the Global Alliance in Management Education (CEMS).

[15] UNFCCC stands for United Nations Framework Convention on Climate Change. For a detailed outline of the course and role play see Paschall and Wüstenhagen (2012) or www.modelunfccc.org.

[16] Although in total 59 students had taken part in both survey waves, students from the University of Cologne (N = 9) were not included in the final sample.

[17] People who traveled by train/plane one-way respectively (N = 2) were excluded from the final sample (see Section 4.2.4).

Table 3
Study 2, Characteristics of the Sample.

Home University	Total Nr. of Students (N = 126)	**Nr. of Survey Respondents (N = 50)**	Distance to Destination in km[a]	Travel Grants [g,h] (return trip)	Net Travel Time 1[c] (one-way)		Estimation of Ticket Prices (return trip)[f,g]	
					Train[b]	Plane[e]	Train	Plane[e]
Rotterdam School of Management	29	**8**	203.89	50	3 h	3 h[d]	75	255
University of St.Gallen	19	**14**	428.41	100	6 h	1h[d]	180	155
Bocconi University	8	**4**	630.84	150	8 h 30 min	1h30min	350	70
Vienna University of Economics and Business	9	**3**	743.00	150	8 h	1 h30	210	260
Corvinus University of Budapest	11	**7**	955.98	200	11h30min	2 h	320	207
Warsaw School of Economics	28	**10**	979.82	200	11 h	2 h	210	134
ESADE Barcelona	13	**3**	1124.13	250	12 h	2 h	480	227
Stockholm School of Economics	9	**1**	1167.42	250	16 h 30 min	2 h	280	177

[a] Distances were calculated between the city centre of Cologne and the city centre of the home university (Source: www.luftlinie.org).
[b] Time indications correspond to the fastest train connections available on trainline.com.
[c] Indications of Net Travel $Time_1$ (= in-vehicle travel time) are rounded to the nearest half hour.
[d] There is no local airport available for these universities. For St. Gallen flight time starts at Zurich Airport. For Rotterdam, flight time starts at Amsterdam Airport.
[e] Flights between Amsterdam-Cologne and Stockholm-Cologne require one stop. All other flight connections are non-stop flights.
[f] The prices are outlined for two weeks in advance booking available on swoodoo.com. The prices which most closely align with the net travel times are indicated.
[g] All prices and travel grants are indicated in EUR.
[h] The indicated amounts correspond to the maximum travel grants available to students. The maximum grant amounts were defined based on net train travel times. Train tickets that were below the max. travel grant amount were refunded for the full amount of their ticket price, but not more.

travel grants varied based on the distance to the destination (University of Cologne) (see Table 3). Table 3 provides detailed information about the trip and sample characteristics of Study 2.

4.2. Measures

4.2.1. Intention to travel by train

Intention to travel by train in the future represents a higher commitment to train travel than consideration of the train as a viable alternative to the plane. As Study 2 took place in a real-life decision-making context and the goal was to measure the intervention effect, the dependent variable asked respondents about their intention. The question reads: "How likely is it, that you will travel more frequently long-distance (>300 km) by train in the future?" Answer options ranged from extremely unlikely to extremely likely on a seven-point scale.

4.2.2. The reference point for making travel time comparisons

Several questions were dedicated to investigating the role of travel time for low-carbon travel choices. To explore how comparisons of the total travel time between different travel modes are made, respondents were first asked about their maximum accepted train travel time. In a second step, students were asked to indicate their maximum additional accepted hours of train travel above the duration of the flight. Subsequently, students were asked which definition of flight time they referred to when indicating their accepted additional train travel time above the duration of the flight. Answer options included the total travel time and the two variations of net travel time definitions (see Fig. 4).

4.2.3. The relative importance of time perceptions

To gain insights into the relative role of time perceptions for their mode choice, students were first asked whether they had gone to Cologne by train, plane, or train and plane one-way respectively. As a follow-up question, students were asked to indicate the importance of different reasons for their modal choices on a seven-point scale (extremely relevant vs. extremely irrelevant).

Students had a few additional answer options compared to the ones included in Study 1. These supplementary questions were included to adhere to students' specific decision-making situation (e.g., influence of peers) and are highlighted in bold in the following.

All students: travel time; travel cost; CO_2 emissions; low complexity of the train/flight ticket booking process; punctuality of the train/flight; possibility to work during the train trip/flight; active support of traveling by train/plane by my **university; travel comfort; fellow students' travel mode choice; lecturer's travel mode choice.**

Only train travelers: Students who traveled by train were additionally asked to indicate the relevance of the **travel grant.**

Only flyers: Earn miles; I was not aware of the option to travel to Cologne by train; **I was not aware of the travel grants for train tickets**.

The similarity of this question with the one asked in the national survey allows exploring whether the relative importance of time perceptions is comparable in a situational, real-life context as opposed to results from stated preferences in the context of a representative survey.

4.2.4. Familiarity with long-distance train travel

As the sample consists of international business students, and public transportation systems can diverge significantly between the eight countries, students were not asked whether they have a travelcard. In the second study, measurements of familiarity were more specific to long-distance travel. Thereby, the focus of Study 2 was twofold. For one, the goal was to find out whether the intervention was effective in making students more familiar with train travel and thus increasing their intention to travel more frequently by train in the future. The second aim was to investigate the role of train travel behavior prior to the trip to Cologne on intentions to travel by train more frequently in the future. For this purpose, two independent variables were operationalized as follows: The first measure consists of the question about how students traveled to Cologne, the answer options being train (N = 35), plane (N = 13) and train/plane one-way (N = 2). Due to the small group of people who traveled by train/plane one-way respectively, this group was not included in the analysis. Secondly, students were asked to indicate the past frequency of their long-distance travels on a six-point scale. For the data analysis, respondents were categorized into two groups, namely occasional and regular train travelers.[18]

4.3. Data analysis and results

4.3.1. Potential bias underlying the comparison of total travel time

Descriptive results show that in both survey waves approximately half of the respondents ($N_{wave\ 1} = 24$; $N_{wave\ 2} = 26$) did not use the total travel time (i.e., the door-to-door calculation of the journey by plane; see Fig. 4) as a reference point when comparing train with air travel time. The other half used one of the two net travel time$_{1,2}$ definitions as a reference point. These results support H2 in

[18] Answer options included 1 = "I have never traveled long-distance by train"; 2 = "The train trip related to the CEMS Model UNFCCC in Cologne was my first long-distance train trip"; 3 = "In the past, I have traveled by train (long-distance) on a few single occasions"; 4 = "On average, I travel (long-distance) by train once a year"; 5 = "On average, I travel (long-distance) by train two to four times a year"; 6 = "On average, I travel (long-distance) by train more than five times a year". Categories 1 through 3 resulted in occasional and categories 4 through 6 in regular train travelers.

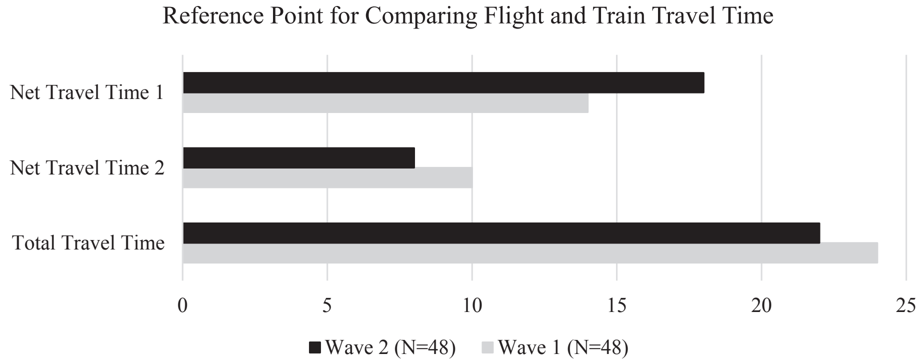

Fig. 4. Descriptive results for the reference point for making flight and train travel time comparisons.

that travel time comparisons between air and train travel are not made based on total travel time calculations.

4.3.2. Travel mode choices: Travel time and time productivity

The descriptive results for Study 2 (see Fig. 5) show that the price argument is central to train and air travelers. In fact, train travelers rated travel grants as the most relevant argument for their modal choice. This demonstrates that monetary incentives can have an effect on students' modal choices. It should be noted, that, to some extent, this result may have been influenced by the travel grants' attractiveness. Also, student samples tend to be more price-sensitive than other samples. Apart from travel grants, the next most important reason to travel by train was CO_2 emissions (M = 6.03, SD = 1.043), followed by travel time productivity (M = 5.43, SD = 1.243), active support of train travel by the university (M = 5.06, SD = 1.878), ticket price (M = 4.69, SD = 1.952), travel comfort (M = 4.57, SD = 1.820) and influence of peers (M = 4.49, SD = 2.161). Contrarily, students who chose to fly had very different reasons for their modal choices. Air travelers indicated three main reasons for their modal choice: total travel time (M = 6.38, SD = 0.961), followed by ticket price (M = 6.08, SD = 1.320) and travel comfort (M = 4.62, SD = 1.446). Similar to Study 1, air travelers indicated significantly fewer reasons to be important compared to train travelers.

Consistent with Study 1, air and train travelers reveal very distinctive perceptions of total travel time and travel time productivity. While travel time productivity is one of the most important arguments in favor of the train trip, time productivity has a mean below 4 in the case of air travelers. Thus, time productivity is not a relevant argument for this group (M = 2.85, SD = 1.519). The opposite is the case for travel time, which is the most relevant argument in favor of flying but seems to be somewhat irrelevant for train travelers (M = 3.51, SD = 1.755). Thus, Study 2 also finds support for H1.

To further investigate the discrepancies between air and train travelers, the results of one-way ANOVA are presented in the following. Significant differences at $p < 0.001$ were found for time productivity (Welch's F (1,18.316) = 30.082, p = .000), total

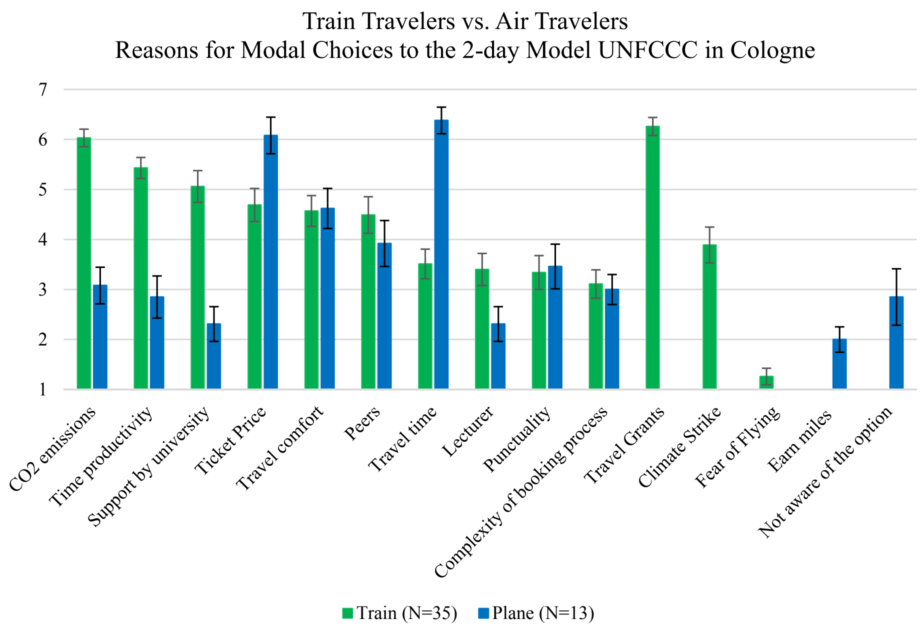

Fig. 5. Reasons for modal choices (train vs. plane) to Cologne.

travel time (Welch's F (1,39.025) = 51.808, $p < .001$), CO_2 emissions (Welch's F (1,17.865) = 52.740, $p < .001$) and active support by the university (Welch's F (1,32.474) = 34.197, $p < .001$). Differences at less significant levels were found for the relevance of the ticket price (Welch's F (1,31.955) = 7.965, $p < .01$) and for the lecturer's influence (Welch's F (1,32.821) = 5.346, $p < .05$). As pointed out above, the high mean score for the importance of travel grants indicates that in a situation without monetary incentives, train travelers would have found the ticket price to be more important. For punctuality of the train/plane, complexity of the ticket booking process, comfort of the chosen travel mode and peer influence, the one-way ANOVA do not find any statistically significant differences between flyers and train travelers.

4.3.3. Regular vs. occasional train travelers

Study 1 has shown that familiarity with train travel in general correlates with the consideration of long-distance train travel. To complement these findings, Study 2 further investigates the role of familiarity with long-distance train travel on future intentions. To do so, the two groups of regular and occasional long-distance train travelers are compared (H4) in the following paragraphs.

Paired sample *t*-tests were conducted for the overall sample (N = 48) as well as for regular (N = 21) and occasional train travelers (N = 27) separately. For the overall sample of respondents that traveled to Cologne (N = 48), paired sample t-tests reveal a higher intention to travel by train after the role play compared to before the role play ($t(47) = -4.134$, $p = 0.000$). The separate paired sample *t*-test for the group of regular train travelers found evidence for a significant difference between the mean scores in waves 1 and 2 ($t(20) = -2.335$, $p = 0.030$). However, the difference in intentions to travel by train in the future was more prominent for occasional train travelers ($t(26) = -3.407$, $p = 0.002$). In fact, their mean was below 4 prior to the intervention (see Fig. 6) and increased to a mean above 4 after the intervention. Between group differences of regular and occasional train travelers in wave 1 and 2 were further investigated through two one-way ANOVA (N = 48). Thereby, in wave 1, occasional and regular train travelers significantly differed in their intention to travel by train in the future ($F(1, 11.318) = 7.06$, $p = 0.011$). This is also the case

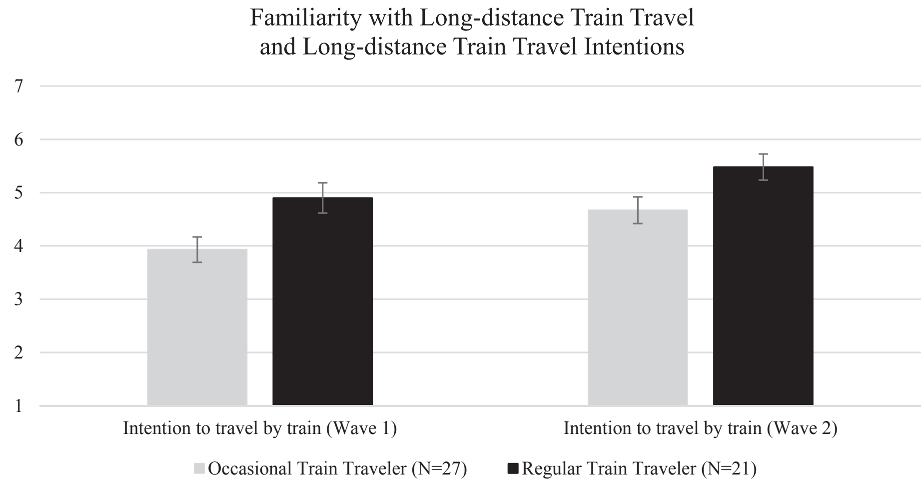

Fig. 6. Future long-distance train travel intentions for occasional and regular long-distance train travelers.

after the intervention, however, at lower statistically significant levels ($F(1, 7.741) = 5.143$, $p = 0.028$).

4.3.4. Train travel experience to Cologne

To further explore the role of familiarity, the results for the effect of the train travel experience to Cologne on students' future long-distance train travel intentions (H5) are presented in the following (see Fig. 7). For the group of students that traveled to Cologne by train, a paired sample *t*-test shows significantly higher train travel intentions after traveling to Cologne ($t(34) = -3.515$, $p = 0.001$). Also for air travelers, a separate paired sample *t*-test found evidence for a difference between the mean scores in waves 1 and 2 ($t(12) = -2.214$, $p = 0.047$), but at less statistically significant levels.

Two one-way ANOVA further explore train (N = 35) and air travelers' (N = 13) travel intentions. Results show that air and train travelers' intentions already differed significantly prior to the intervention ($F(1, 7.810) = 4.655$, $p = 0.036$). The significant difference became more pronounced after the trip to Cologne ($F(1, 11.129) = 7.774$, $p = 0.008$), suggesting that the train travel

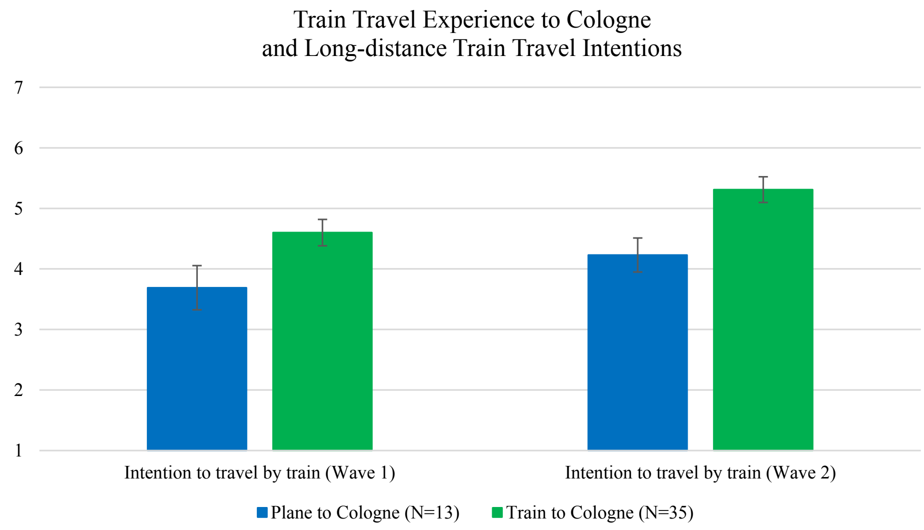

Fig. 7. Future long-distance train travel intentions for train and air travelers.

experience to Cologne was effective in increasing train travel intentions.

5. Discussion

5.1. The role of travel time perceptions

5.1.1. Time perceptions differ systematically

The findings of Studies 1 and 2 indicate that (likely) train travelers value productive travel time significantly more than air travelers, while the latter are significantly more concerned about minimizing total travel time. These results support H1 suggesting that there may be systematic differences in (likely) air and train travelers' time perceptions. As such, this study supports the proposal that transport policy design should move beyond assessing travel time as an opportunity cost (see Mokhtarian and Salomon, 2001; Lyons and Urry, 2005; Jain and Lyons, 2008) for the case of long-distance travel. In the future, the extent to which business travelers can use their travel time productively will not only depend on the digitization trend and increasing flexibility of work practices (Wardman and Lyons, 2016), but also on the service quality level of railway companies (Li, 2003; Bouscasse and de Lapparent, 2019; Van Hagen and Van Oort, 2019). In this respect, the willingness of companies and private individuals to pay for increased travel time quality in the context of low-cost air travel needs to be explored.

As opposed to likely train travelers, likely air travelers seem to be mainly concerned about minimizing travel costs and time, but not about travel time productivity. Study 1 provides a possible explanation for this discrepancy between likely air and train travelers. The mean for "I have never considered the train as an alternative option to the plane" was close to 4 (out of 7) in the case of likely business and private air travelers. Thus, likely air travelers are rather unlikely to have thought about the benefits of train travel in an in-depth manner. These results lend support to the findings by Kenyon and Lyons (2003) that travelers do not inform themselves about substitutes but rely on habitual modal choices. In order for likely air travelers to consider the train in the first place, raising awareness about the benefits of train travel may be necessary. Persuasion of a modal change becomes more likely if travelers not only receive information about cost and travel time of different alternatives, but also about key concerns such as comfort and convenience (Kenyon and Lyons, 2003).

5.1.2. Climate friendliness is key

While the productive use of travel time was a key concern of (likely) train travelers in both studies, CO_2 emissions were a slightly more important criterion in favor of the train. The link between sustainable behavior and the preference in favor of the train is in line with an earlier study by Bieger and Laesser (2004). The results of this paper suggest that attitudes towards climate change remain a central driver of (likely) train travelers' low-carbon travel mode choices. Policymakers seeking to foster low-carbon travel choices should therefore aim at increasing awareness about the large difference in CO_2 emissions between air and train travel.

5.1.3. Air and train travel time comparisons

Half of the respondents in Study 2 used one of the two net travel $\text{time}_{1,2}$ definitions as a reference point for comparing total air with train travel times. Thus, Study 2 provides initial evidence for a potential bias when making comparisons between train and air travel times. This conclusion can, however, not be generalized beyond the sample of international business students. Research should further explore antecedents to this potential bias with a large representative sample as there is a need to further investigate the hidden travel time costs of air travel. Sauter-Servaes et al. (2019) propose that current travel planning applications indicate net travel times for air travel (i.e., underestimation of waiting times at airports) and total travel times for train travel (Sauter-Servaes et al., 2019), thereby reinforcing travelers' existing biases.

5.2. The role of familiarity

5.2.1. Familiarity with public transportation use

In the context of the market entry of low-cost carriers, Bieger and Laesser (2004) found familiarity to have a positive effect on the preference for daytime train connections. In a context in which short-haul flights have become much more common, this paper was able to confirm the critical role of familiarity with public transportation for the consideration of long-distance train travel. For one, the frequency of public transportation use generally translated into a higher consideration of train travel. Secondly, owning a regular travel pass (GA or a half fare travelcard) was found to be a critical determinant compared to not owning a travelcard. As pointed out by Garcia-Sierra et al. (2015), long-term decisions such as buying a car will affect short-term travel choices. In the realm of public transportation, purchasing a travel pass could be seen as a long-term investment that leads to increased public transportation use. As shown in Study 1, ownership of a travel pass may not only affect short-term modal choices between car and public transportation use. It also seems to have a positive external effect on considering the train instead of the plane. A possible reason could be that travelcard holders are better informed about the variety of train travel options than non-holders. Point-to-point travelcards, which are only valid for a specific commute, are the exception. Although most point-to-point travelcard owners are also frequent public transportation users, they did not reveal a significantly higher consideration of long-distance train travel than non-owners. Previous studies have found the trip purpose to be crucial for modal choices (e.g., Mackie et al., 2001; O'Fallon et al., 2004; Yang et al., 2018). Thus, this group may limit its public transportation use to specific commutes and prefer other modes for other purposes. As such, a point-to-point travelcard purchase is unlikely to translate into short-term modal choices.

In sum, these findings highlight the importance of fostering public transportation use as well as promoting travelcards that are valid beyond a particular commute. It is important to consider that these subscription types can result in positive spillover effects on modal choices that are not directly a part of subscription offers. This insight is relevant for research currently exploring mobility service bundling approaches to increase public transportation accessibility and decrease car use (see, e.g., Guidon et al., 2020).

5.2.2. The role of familiarity with long-distance train travel

While past research has investigated strategies to foster public transportation, the field intervention in Study 2 is one of the first attempts to investigate the effects of train travel experience on intentions to travel by train in the future.

The results of Study 2 find support for H4. Interestingly, occasional train travelers showed rather no intention to travel by train before the intervention (mean below 4 out of 7), while the intention increased significantly and became rather high after the intervention (mean above 4). Thus, increased familiarity and experience with long-distance train travel may be a part of the solution to persuade inexperienced train travelers to switch from plane to train. Study 2 also supports H5, as the intentions of students who traveled to Cologne by train increased after the intervention.

The overall results of Study 2 lend support to extant literature which suggests that experience (Fujii and Kitamura, 2003; Thøgersen and Møller, 2008) and information (Kenyon and Lyons, 2003) about alternative modes can be vital in breaking old habits and considering alternative travel modes. It is, however, remarkable that air travelers' intentions to travel by train significantly increased from a mean below 4 (out of 7) in wave 1 to a mean of 4.9 in wave 2. These results propose that the intervention was also successful in gaining the attention of students who were not part of the train travel experience itself. One possible reason for this may be that interventions within a group can successfully reach people who do not react to the specific incentives introduced through the intervention. Perceived social norms (i.e., fellow students' modal choices and attitudes towards train travel) may partly explain air travelers' change in intentions. Social factors are important drivers of modal choices (Garcia-Sierra et al., 2015). They may additionally explain why regular train travelers, although at lower levels than occasional train travelers, revealed statistically significantly higher intentions after the intervention, although at lower levels than occasional travelers.

6. Conclusion

6.1. General conclusions and implications for policy and practice

This paper finds familiarity with train travel and time perceptions to be important determinants of low-carbon travel mode choices in two independent studies.

Firstly, time perceptions systematically vary between (likely) air and train travelers. The former are mainly concerned about minimizing travel time and the latter highly value travel time productivity. These results have implications for communication strategies of railway operators. Air traveling habits could be addressed through communication campaigns on the productive use of travel time. As CO_2 emissions were consistently key arguments for considering (Study 1) and choosing (Study 2) train travel, focusing communication messages on time perceptions could be effective in targeting segments that are unresponsive to the climate argument. As such, this strategy could be particularly successful in targeting time-sensitive travelers with positive climate attitudes. Also, motivational campaigns can be more effective in building the basis for behavior change if habits are weak but intentions to change behavior are strong (Gardner, 2009). Thus, campaigns about productive time use are unlikely to result in behavior change of people with a strong flying habit.

Secondly, apart from time, ticket costs may be a key barrier for price-sensitive customer segments or travelers who are rather unfamiliar with the co-benefits of train travel (e.g., travel time productivity). While in both studies travel costs were relevant for (likely) train and air travelers, costs were always significantly more important for (likely) flyers. In Study 2, however, travel grants seemed to be a pivotal motivation to choose the train, which may be because students are a rather price-sensitive traveler segment. Targeting low to middle-income segments with effective pricing strategies could pose an opportunity for policymakers and railway operators. As both studies find that familiarity with train travel can increase customers' awareness of train travel benefits, attractive travelcard offers at the national and international levels may be a worthwhile investment with the aim of building long-term customer relationships. In this respect, students, a target group with a potentially high customer lifetime value, would be particularly interesting. #DiscoverEU,[19] which has allowed for nearly 30′000 18-year olds to become familiar with Interrail travel free of charge, could be a step in the right direction.

Finally, these strategies are likely to be more effective if complementary strategies such as taxes on flight ticket prices follow. The effectiveness of a flight ticket tax will depend on price-elasticities of the demand (Tol, 2007; Falk and Hagsten, 2019) as well as the public acceptance of such a regulatory measure (Higham et al., 2016), which are both subject to national and socio-cultural disparities. As shown by Cousse and Wüstenhagen (2019), only 30% of Swiss voters would be against a flight ticket tax, which would correspond to a minority of Swiss voters.

6.2. Limitations and future research

While this study provides several important insights on low-carbon, long-distance travel mode decision-making, the following limitations are outlined as opportunities for further research.

Both studies included in this paper focus on two specific but relevant samples in terms of studying frequent air travel behavior, namely Swiss travelers as well as international business students. As preferences are context-dependent, scholars could complement the findings of Study 1 by investigating drivers of low-carbon modal choices in the context of other countries. While results of Study 1 are based on a nationally representative sample, the results drawn from international business students in Study 2 are not. There are a number of psychological studies that use student samples (Hanel and Vione, 2016; e.g., Bamberg et al., 2003). However, according to Greenfield (2014) socioeconomic groups can be more distinct from each other than countries. Thus, conclusions drawn from Study 2 (H2, H4, H5) have limited external validity as they are not applicable beyond the sample of international business students. A central value of Study 2 is that its research design goes beyond the investigation of stated preferences. Study 2 reveals preferences formed in a real-life and concrete decision-making context. Thus, Study 2 allowed to identify important intervention points for decarbonizing transportation by investigating actual travel choices of a sample that consists of people who are current frequent air travelers as well as future decision-makers in the private sector. In sum, replicating Study 2 with a larger sample is an opportunity for future research. Methodologically, the replication could either be based on an online experiment or a more large-scale field intervention (e.g., providing financial incentives to travel by train in the context of larger events).

A further limitation of Study 2 relates to its longitudinal design, which was based on a three-month-long interval between the two data collection points. Further exploring the longevity of the effect of long-distance train travel training on intentions and behaviors provides an opportunity for future research. This is particularly important as past research has found a free one-month travelcard to break car travel habits, however, the effect of the free trial experience did not last in the long-term (Thøgersen and Møller, 2008). In the context of long-distance travel, future contributions could investigate whether field interventions that aim at promoting eco-friendly travel modes and are based on monetary incentives such as travel grants or the #DiscoverEU project can effectively lead to long-term habitual changes.

Finally, travel time perceptions seem to be a fundamental driver of low-carbon travel mode choices. Research should investigate this aspect in more depth as it may turn out to be important when it comes to persuading people to travel long-distance by train. This could entail studies focusing on how different stages of the air and train travel journey (e.g., booking process, retention time) drive travel time perceptions.

CRediT authorship contribution statement

Nathalie Dällenbach: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization.

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[19] See: http://www.youdiscover.eu.

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Appendix A. Study 1, means and ANOVA, comparison between likely train and air travelers: Reasons for travel mode choices

Reasons for considering the train as a viable option vs. not a viable option.	Mean and standard deviation		ANOVA
	Likely train travelers	Likely air travelers	
Private travelers			
CO_2 emissions	M = 5.66, SD = 1.78	M = 3.09, SD = 2.06	Welch's $F_{(1,238.309)} = 220.045$, p < .001
Punctuality	M = 4.86, SD = 1.93	M = 4.45, SD = 2.28	Welch's $F_{(1,235.518)} = 4.675$, p < .05
Complexity of the booking process	M = 4.52, SD = 2.25	M = 3.69, SD = 2.30	Welch's $F_{(1, 259.266)} = 18.000$, p < .001
Travel time	M = 4.49, SD = 2.08	M = 5.91, SD = 1.91	Welch's $F_{(1, 282.348)} = 72.093$, p < .001
Travel cost	M = 4.55, SD = 2.12	M = 5.07, SD = 2.12	Welch's $F_{(1, 255.825)} = 7.717$, $p < .01$
Earn miles	–	M = 2.51, SD = 2.12	–
Never considered train travel	–	M = 3.73, SD = 2.28	–
Business travelers			
CO_2 emissions	M = 5.5, SD = 1.89	M = 3.07, SD = 2.13	Welch's $F_{(1,160.02)} = 111.513$, $p < .001$
Time productivity	M = 5.45, SD = 1.88	M = 3.12, SD = 2.34	Welch's $F_{(1, 149.914)} = 87.437$, $p < .001$
Punctuality	M = 5.27, SD = 1.77	M = 4.54, SD = 2.23	Welch's $F_{(1, 148.360)} = 9.494$, $p < .01$
Complexity of the booking process	M = 4.73, SD = 2.14	M = 3.95, SD = 2.45	Welch's $F_{(1, 158.258)} = 8.685$, $p < .01$
Travel time	M = 4.69, SD = 2.02	M = 6.33, SD = 1.44	Welch's $F_{(1,244.493)} = 84.992$, $p < .001$
Travel cost	M = 4.49, SD = 2.06	M = 5.05, SD = 2.24	Welch's $F_{(1,164.656)} = 5.179$, $p < .05$
Support by company	M = 4.21, SD = 2.32	M = 2.76, SD = 2.19	Welch's $F_{(1,183.828)} = 34.263$, $p < .001$
Earn miles	–	M = 2.73, SD = 2.32	–
Never considered train travel	–	M = 4.04, SD = 2.33	–

Appendix B. Study 1, Mean, standard deviation and ANOVA, frequency of public transportation use and consideration of long-distance train travel

	Mean	Std. Deviation	ANOVA
Private travelers			
Frequent	5.68	1.876	Welch's $F_{(2, 253.831)} = 18.411$, $p = .000$
Moderate	5.12	2.079	
Infrequent	4.43	2.300	
Business travelers			
Frequent	5.47	2.048	Welch's $F_{(2, 143.003)} = 5.724$, $p = .004$
Moderate	5	2.173	
Infrequent	4.48	2.449	

Appendix C. Study 1, Games-Howell post-hoc test results, frequency of public transportation use and consideration of long-distance train travel

Differences between frequent, moderate and infrequent public transportation users.	Mean difference	Std. error	*p*	95% Confidence interval	
				Lower Bound	Upper Bound
Private travelers					
Moderate – infrequent users	0.688*	0.258	0.023	0.08	1.3
Frequent – moderate users	0.562*	0.162	0.002	0.18	0.94
Frequent – infrequent users	1.250*	0.229	0.000	0.71	1.79
Business travelers					
Moderate – infrequent users	0.524	0.367	0.33	−0.35	1.39
Frequent – moderate users	0.468	0.229	0.104	−0.07	1.01
Frequent – infrequent users	0.992*	0.329	0.01	0.21	1.78

*The mean difference is significant.

Appendix D. Study 1, Mean, standard deviation and ANOVA, travelcard ownership on consideration of long-distance train travel

	Mean	Std. Deviation	ANOVA
Private travelers			
No Travelcard	4.65	2.293	Welch's $F_{(5,\ 202.007)} = 9.711$, p = .000
GA	6.06	1.630	
Half fare (only)	5.52	1.947	
Half fare (+point-to-point)	5.23	2.071	
Point-to-point	5.02	1.907	
Other	5.97	1.850	
Business travelers			
No Travelcard	4.51	2.393	Welch's $F_{(5,\ 117.471)} = 4.214$, p = .001
GA	5.64	1.884	
Half fare (only)	5.48	1.994	
Half fare (+point-to-point)	5.10	2.290	
Point-to-point	4.53	2.273	
Other	6	1.952	

Appendix E. Study 1, Games-Howell post hoc test results, travelcard ownership and consideration of long-distance train travel

Differences between Travelcard types	Mean difference	Std. Error	*p*	95% Confidence Interval	
				Lower Bound	Upper Bound
Private travelers					
No Travelcard - GA	−1.405*	0.221	0.000	−2.04	−0.77
No Travelcard - Half fare (only)	−0.870*	0.205	0.000	−1.46	−0.28
No Travelcard - Half fare (+point-to-point)	−0.575	0.250	0.198	−1.29	0.14
No Travelcard - Point-to-point	−0.365	0.306	0.841	−1.25	0.52
No Travelcard - other	−1.318*	0.364	0.008	−2.39	−0.24
Business travelers					
No Travelcard - GA	−1.125*	0.329	0.010	−2.07	−0.18
No Travelcard - Half fare (only)	−0.973*	0.285	0.010	−1.79	−0.15
No Travelcard - Half fare (+point-to-point)	−0.586	0.368	0.603	−1.65	0.47
No Travelcard - Point-to-point	−0.019	0.463	1.000	−1.38	1.34
No Travelcard - Other	−1.489*	0.485	0.042	−2.95	−0.03

*The mean difference is significant.

Appendix F. Comparison of the characteristics of the two independent samples used in Study 1 and Study 2

Variables		Sample Study 1 (N = 1021)	Sample Study 2 (N = 48)	Swiss Population
Gender	Female	51%	50%	51%
	Male	49%	50%	49%
Age	15–19	6%	0%	6%
	20–29	16%	100%	15%
	30–44	25%	0%	25%
	45–59	26%	0%	27%
	60+	27%	0%	26%
	Western Switzerl. (French-speaking)	25%	N/A	25%
Region (excl. Ticino)	Alps & Prealps	24%	N/A	24%
	Swiss Plateau West	22%	N/A	22%
	Swiss Plateau East	29%	N/A	29%
Political Attitude	Right-wing	45%	N/A	51%
	Center	27%	N/A	23%
	Left-wing	21%	N/A	27%
Education	Low/medium	58%	0%	56%
	High	42%	100%	44%

References

Abda, M.B., Belobaba, P.P., Swelbar, W.S., 2012. Impacts of LCC growth on domestic traffic and fares at largest US airports. J. Air Transp. Manage. 18 (1), 21–25.
Air Transport Action Group [ATAG], 2019. Facts and Figures. Retrieved on June 25th 2019 from: https://www.atag.org/facts-figures.html.
Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Human Decision Process. 50 (2), 179–211.
Albalate, D., Bel, G., Fageda, X., 2015. Competition and cooperation between high-speed rail and air transportation services in Europe. J. Transp. Geogr. 42, 166–174.
Bamberg, S., Ajzen, I., Schmidt, P., 2003. Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action. Basic Appl. Social Psychol. 25 (3), 175–187.
Bargh, J.A., 1989. Conditional automaticity: varieties of automatic influence in social perception and cognition. In: Uleman, J.S., Bargh, J.A. (Eds.), Unintended thought. Guilford Press, New York.
Becken, S., 2007. Tourists' perception of international air travel's impact on the global climate and potential climate change policies. J. Sustain. Tourism 15 (4), 351–368.
Behrens, C., Pels, E., 2012. Intermodal competition in the London-Paris passenger market: High-Speed Rail and air transport. J. Urban Econ. 71 (3), 278–288.
Bieger, T., Laesser, C., 2001. The role of the railway with regard to mode choice in medium range travel. Tourism Rev. 56 (1/2), 33–39.
Bieger, T., Laesser, C., 2004. The market entry of low cost airlines (LCA): Implications for mode choice between Switzerland and Germany. In: 4th Swiss Transport Research Conference (STRC), Monte Verita, Asona.
Bieger, T., Wittmer, A., Laesser, C., 2007. What is driving the continued growth in demand for air travel? Customer value of air transport. J. Air Transp. Manage. 13 (1), 31–36.
Bouscasse, H., de Lapparent, M., 2019. Perceived comfort and values of travel time savings in the Rhône-Alpes Region. Transport. Res. Part A: Policy Practice 124, 370–387.
Cames, M., Graichen, J., Siemons, A., Cook, V., 2015. Emission Reduction Targets for International Aviation and Shipping. Policy Department A: Economic and Scientific Policy, European Parliament, Brussels. Retrieved on July 28th 2019 from: http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf.
Cascetta, E., Papola, A., Pagliara, F., Marzano, V., 2011. Analysis of mobility impacts of the high speed Rome-Naples rail link using withinday dynamic mode service choice models. J. Transport Geogr. 19 (4), 635–643.
Cheng, Y.H., Huang, T.Y., 2014. High speed rail passenger segmentation and ticketing channel preference. Transport. Res. Part A: Policy Practice 66, 127–143.
Cohen, S.A., Higham, J.E., Cavaliere, C.T., 2011. Binge flying: Behavioral addiction and climate change. Ann. Tourism Res. 38 (3), 1070–1089.
Cohen, S.A., Gössling, S., 2015. A darker side of hypermobility. Environ. Plan. A: Econ. Space 47 (8), 166–1679.
Cohen, S.A., Hanna, P., Gössling, S., 2018. The dark side of business travel: a media comments analysis. Transport. Res. Part D: Transp. Environ. 61, 406–419.
Cousse, J., Wüstenhagen, R., 2019. 9th Consumer Barometer of Renewable Energy. Retrieved on June 7th 2020 from: https://kuba.iwoe.unisg.ch.
Dedeke, A.N., 2016. Travel web-site design: Information task-fit, service quality and purchase intention. Tourism Manage. 54, 541–554.
Dobruszkes, F., Mondou, V., 2013. Aviation liberalization as a means to promote international tourism: The EU–Morocco case. J. Air Transp. Manage. 29, 23–34.
Duranton, S., Audier, A., Hazan, J., Langhorn, M.P., Gauche, V., 2017. The 2017 European Railway Performance Index. Retrieved on July 2nd 2019 from: https://www.bcg.com/en-ch/publications/2017/transportation-travel-tourism-2017-european-railway-performance-index.aspx.
European Commission, 2010. High-speed Europe - A sustainable link between citizens. Publications office of the European Union: Luxemburg.
Falk, M., Hagsten, E., 2019. Short-run impact of the flight departure tax on air travel. Int. J. Tourism Res. 21 (1), 37–44.
Federal Council, 2020. Statement of the Federal Council of 20/11/2019. [Interpellation 19.4281]. Retrieved on June 15th 2020 from: https://www.parlament.ch/ de/ratsbetrieb/suche-curia-vista/geschaeft?AffairId = 20194281.
Fowkes, A., 2001. Principles of valuing business travel time savings. ITS Working paper 562. ITS. Institute for Transport Studies, University of Leeds, Leeds.
Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation 30 (1), 81–95.
Garcia-Sierra, M., van den Bergh, J.C., Miralles-Guasch, C., 2015. Behavioural economics, travel behaviour and environmental-transport policy. Transport. Res. Part D: Transp. Environ. 41, 288–305.
Gardner, B., 2009. Modelling motivation and habit in stable travel mode contexts. Transport. Res. Part F: Traffic Psychol. Behav. 12 (1), 68–76.
Givoni, M., Dobruszkes, F., 2013. A review of ex-post evidence for mode substitution and induced demand following the introduction of high-speed rail. Transp. Rev. 33 (6), 720–742.
Global Sustainable Tourism Dashboard, 2018. Aviation Emissions. Retrieved on June 25th 2019 from: https://www.tourismdashboard.org/explore-the-data/carbon-emissions/.
Graham, A., Metz, D., 2017. Limits to air travel growth: the case of infrequent flyers. J. Air Transp. Manage. 62, 109–120.
Greenfield, P.M., 2014. Sociodemographic differences within countries produce variable cultural values. J. Cross-Cultural Psychol. 45 (1), 37–41.
Guidon, S., Wicki, M., Bernauer, T., Axhausen, K., 2020. Transportation service bundling–for whose benefit? Consumer valuation of pure bundling in the passenger transportation market. Transport. Res. Part A: Policy Practice 131, 91–106.
Gundelfinger-Casar, J., Coto-Millán, P., 2017. Intermodal competition between high-speed rail and air transport in Spain. Utilities Policy 47, 12–17.
Hanel, P.H., Vione, K.C., 2016. Do student samples provide an accurate estimate of the general public? PloS one 11 (12), e0168354.
Hares, A., Dickinson, J., Wilkes, K., 2010. Climate change and the air travel decisions of UK tourists. J. Transp. Geogr. 18 (3), 466–473.
Higham, J., Cohen, S.A., Cavaliere, C.T., Reis, A., Finkler, W., 2016. Climate change, tourist air travel and radical emissions reduction. J. Clean. Prod. 111, 336–347.
Hoikkala, H., Magnussen, N., 2019. As 'Flying Shame' Grips Sweden, SAS Ups Stakes in Climate Battle. Bloomberg.com. Retrieved on June 25th 2019 from: https://www.bloomberg.com/news/articles/2019-04-14/as-flying-shame-grips-sweden-sas-ups-stakes-in-climate-battle.
IEA, 2019. The Future of Rail. Retrieved on September 13th 2019 from: https://webstore.iea.org/the-future-of-rail.
Kenyon, S., Lyons, G., 2003. The value of integrated multimodal traveler information and its potential contribution to modal change. Transport. Res. Part F: Traffic Psychol. Behav. 6 (1), 1–21.
Jain, J., Lyons, G., 2008. The gift of travel time. J. Transport Geog. 16 (2), 81–89.
Kolirin, L., 2018, October 30. EasyJet plans electric planes by 2030. CNN. Retrieved on July 27th 2019 from: https://edition.cnn.com/travel/article/electric-easyjet-planes-intl/index.html.
LaMondia, J.J., Fagnant, D.J., Qu, H., Barrett, J., Kockelman, K., 2016. Shifts in long-distance travel mode due to automated vehicles: Statewide mode-shift simulation experiment and travel survey analysis. Transport. Res. Rec. 2566 (1), 1–11.
Li, Y.W., 2003. Evaluating the urban commute experience: a time perception approach. J. Public Transport. 6 (4), 41–67.
Lyons, G., Urry, J., 2005. Travel time use in the information age. Transport. Res. Part A: Policy Practice 39 (2–3), 257–276.
Mackie, P.J., Jara-Dıaz, S., Fowkes, A.S., 2001. The value of travel time savings in evaluation. Transport. Res. Part E: Logistics Transport. Rev. 37 (2–3), 91–106.
Mokhtarian, P.L., Salomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. Transport. Res. Part A: Policy practice 35 (8), 695–719.
O'Fallon, C., Sullivan, C., Hensher, D.A., 2004. Constraints affecting mode choices by morning car commuters. Transp. Policy 11 (1), 17–29.
Oxley, D., Jain, C., 2015. Chapter 1.4 Global Air Passenger Markets: Riding Out Periods of Turbulence. In: Crotti, R., Misrahi, T. (Eds.), The Travel & Tourism Competitiveness Report 2015, pp. 59–63. Retrieved on June 26th 2019 from: http://www3.weforum.org/docs/TT15/WEF_TTCR_Chapter1.4_2015.pdf.
Paschall, M., Wüstenhagen, R., 2012. More than a game: Learning about climate change through role-play. J. Manage. Educat. 36 (4), 510–543.
Peeters, P., Higham, J., Kutzner, D., Cohen, S., Gössling, S., 2016. Are technology myths stalling aviation climate policy? Transp. Res. Part D: Transport Environ. 44, 30–42.
REN21, 2019. Global Status Report 2019. Chapter 01: Global Overview. Retrieved on July 21st 2019 from: https://www.ren21.net/gsr-2019/chapters/chapter_01/chapter_01/.
Rey, B., Myro, R.L., Galera, A., 2011. Effect of low-cost airlines on tourism in Spain. A dynamic panel data model. J. Air Transp. Manage. 17 (3), 163–167.
Ro, C. 2019. Some firms give more time off to those who shun plane travel. bbc.com. Retrieved on December 5th 2019 from: https://www.bbc.com/worklife/article/20190918-some-firms-give-more-time-off-to-those-who-shun-plane-travel.
Rogers, E.M., 2010. Diffusion of Innovations, fourth ed. Simon and Schuster, New York.

Roland Berger, 2017. Think:Act. New developments in aircraft electrical propulsion. Retrieved July 28th 2019 from: https://www.rolandberger.com/en/Publications/New-developments-in-aircraft-electrical-propulsion.html.
Sauter-Servaes, T., Krautscheid, T., Schober, A., 2019. A level playing field for comparing air and rail travel times. Open Transp. J. 13 (1), 48–56.
Shaw, S., Thomas, C., 2006. Discussion note: Social and cultural dimensions of air travel demand: Hyper-mobility in the UK? J. Sustain. Tourism 14 (2), 209–215.
Sims, R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D'Agosto, M., Dimitriu, D., Figueroa Meza, M.J., Fulton, L., Kobayashi, S., Lah, O., McKinnon, A., Newman, P., Ouyang, M., Schauer, J.J., Sperling, D., Tiwari, G., 2014. Transport. In: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlómer, S., von Stechow, C., Zwickel, T., Minx, J.C. (Eds.), Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovern- mental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
Steer Davis Gleave, 2006. Air and rail competition and complementarity. Final report for the. European Commission (DG TREN).
Steer Davis Gleave, 2016. Study on the prices and quality of rail passenger services. Final report for the European Commission (DG MOVE).
Sun, X., Zhang, Y., Wandelt, S., 2017. Air transport versus high-speed rail: an overview and research agenda. J. Adv. Transport.
Sussman, R., Tan, L.Q., Kormos, C.E., 2020. Behavioral interventions for sustainable transportation: an overview of programs and guide for practitioners. In: J. Zhang (Ed.), Transport and Energy Research. A Behavioral Perspective, pp. 315–371.
Swiss Federal Office of Statistics, 2018a. Ständige Wohnbevölkerung nach Geschlecht und Altersklasse, definitive Jahresergebnisse, 2014-2018. Bundesamt für Statistik, STATPOP, Switzerland. Retrieved on September 15th 2019 from: https://www.bfs.admin.ch/bfs/en/home/statistics/catalogues-databases/tables.assetdetail.9466990.html.
Swiss Federal Office of Statistics, 2018b. Statistiken finden – Bevölkerung – Stand und Entwicklung – Räumliche Verteilung. Retrieved on September 15th 2019 from: https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung/stand-entwicklung/raeumliche-verteilung.html.
Swiss Parliament, 2019. Groups in the Chamber: National Council. Retrieved on 27.09.2019 from: https://www.parlament.ch/de/organe/nationalrat/sitzordnung-nr.
Thøgersen, J., Møller, B., 2008. Breaking car use habits: The effectiveness of a free one-month travelcard. Transportation 35 (3), 329–345.
Tol, R.S., 2007. The impact of a carbon tax on international tourism. Transport. Res. Part D: Transp. Environ. 12 (2), 129–142.
Triandis, H.C., 1977. Interpersonal Behavior. Brooks/Cole Publishing Company, Monterey, California.
Tsui, K.W.H., 2017. Does a low-cost carrier lead the domestic tourism demand and growth of New Zealand? Tourism Manage. 60, 390–403.
Tversky, A., Kahneman, D., 1974. Judgment under uncertainty: Heuristics and biases. Science 185 (4157), 1124–1131.
Van Hagen, M., Van Oort, N., 2019. Improving railway passengers experience: two perspectives. J. Traffic Transport. Eng. 7, 97–110.
Verplanken, B., Aarts, H., Van Knippenberg, A., 1997. Habit, information acquisition, and the process of making travel mode choices. Eur. J. Social Psychol. 27 (5), 539–560.
Wardman, M., Lyons, G., 2016. The digital revolution and worthwhile use of travel time: Implications for appraisal and forecasting. Transportation 43 (3), 507–530.
Wilkes, W., Weiss, R., 2019. German Air Travel Slump Points to Spread of Flight Shame. Bloomberg.com. Retrieved on December 25th 2019 from: https://www.bloomberg.com/ news/articles/2019-12-19/german-air-travel-slump-points-to-spread-of-flight-shame.
WWF (2015). Unsere Ziele. Flugverkehr. Retrieved on June 25th 2019 from: https://www.wwf.ch/de/unsere-ziele/flugverkehr.
Yang, Y., Wang, C., Liu, W., Zhou, P., 2018. Understanding the determinants of travel mode choice of residents and its carbon mitigation potential. Energy Policy 115, 486–493.