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Rail or plane: a pilot study on Dutch tourists' price sensitivity as a function of travel time

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Aim: As part of its climate and sustainability policies, the European Union actively fosters the transition from air to rail travel, for example by improving the international railway infrastructure, liberalizing the European railway market and introducing an international booking system for train travel. On the demand side, price is a crucial factor. This pilot study examines the effect of train ticket prices on holiday travel mode choice.

Design/methods: In a stated preference survey targeting holiday trips from Amsterdam to eight of Europe's most popular city destinations, participants in the Netherlands were asked to choose between train and plane, given scenarios for price and travel time.

Conclusion / findings: The results point to a significant correlation between price sensitivity and travel time, with price sensitivity being lowest for short and long trips and highest for medium-range trips.

Originality / value of the article: The findings can inform pricing strategies of railway companies and the design of fiscal measures (taxes, subsidies) to strengthen the competitive position of European rail versus aviation.

Keywords: holiday travel mode choice, train ticket price, sustainable tourism
JEL: L92, L93, D12, R41, Q58

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1. Introduction

Aviation is a major contributor to the climate crisis, with its emissions being among the most difficult to abate through technological development (Bergero et al. 2023). Substituting rail for air on short-range and mid-range trips can be an effective climate policy, given that much of rail transport already runs on (renewable) electricity. To encourage the switch from air to rail, the European Commission actively seeks to strengthen rail travel's competitiveness vis-à-vis air travel by improving international rail connections and introducing new ones, pressuring rail operators to develop an international ticketing system (European Commission 2021), increasing duties on jet fuel, introducing value-added tax (VAT) on flight tickets, and lowering VAT on train tickets.

Contemporary research underscores the critical importance of these initiatives. Travel time and travel cost are the main determinants of modal choice for both domestic (Bergantino, Madio 2020) and international trips (Witlox et al. 2022). Longer travel times and higher prices are also the most common reasons for choosing planes over trains for holiday trips (Dällenbach 2020; Kroes, Savelberg 2019). Improving rail travel's competitive position is therefore essential. Unfortunately, perceptions seem to favor air travel. According to Witlox et al. (2022), travelers tend to equate air travel time to in-vehicle time, disregarding the time spent waiting at the airport and traveling to and from the airport. Conversely, for rail travel, travelers include all these categories.

Recent studies have also highlighted the nuanced aspects of travel cost perception. Little is known about the difference in travel cost perception for long-distance trips, but studies often compare the ticket costs of air travel directly with those of rail transport, not considering fuel and parking costs, which are generally higher for air travel (Witlox et al. 2022). Additionally, Peeters and Dubois (2019) indicate that integrating external costs such as environmental impacts and infrastructure maintenance into pricing strategies can alter consumer preferences significantly.

Moreover, contemporary research has started to explore the role of psychological factors in modal choice. For instance, Cohen et al. (2020) argue that travelers' environmental awareness and willingness to reduce their carbon footprint can influence their preference for rail over air travel, especially when supported by effective marketing and policy measures. Similarly, studies by Higham et al. (2021) suggest that policy interventions aimed at reducing the frequency of short-haul flights can be more effective when combined with improvements in rail service quality and reliability.

To inform railway pricing strategies and/or EU policies aimed at fostering the transition from air to rail transport for mid-range holiday trips, this study explores the effects of a range of relative price changes on the competitiveness of rail travel versus air travel in the context of Dutch holiday travel. The central research question was:

To what extent does train ticket price affect holiday travel mode choice?

Our research hypothesis was that train ticket prices significantly affect holiday travel mode choice. This study aims to provide an understanding of the factors influencing travel mode choice to inform more effective policy and pricing strategies.

2. Materials and methods

This study considers the modal choice of holiday-makers travelling between Amsterdam and eight of the most popular city destinations, namely Barcelona, Berlin, Copenhagen, London, Munich, Paris, Vienna and Zurich, located at a great-circle distance from Amsterdam, ranging from 357 km (London) to 1239 km (Barcelona). For simplicity's sake, the model only includes the two central variables of travel time and travel, and only for air and rail transport, the two biggest competitors for city trips (Eurostat 2023). Other travel modes such as cars and buses were not included in the model. Air travel costs were kept constant at the 5-day average (23–27 June 2023) of lowest prices for one-way tickets. One-way ticket prices were preferred over return ticket prices, because the latter are often part of special package deals and fluctuate heavily in price. Travel time was also kept constant at the lowest values available in the same period. It includes both in-vehicle and out-of-vehicle travel time. Other possible influencing factors such as travel comfort, departure time, and (the number of) train transfers were disregarded. Only train travel costs were varied in the analysis. Next to the base level (no change relative to 5-day average price around 25 June 2023), four levels of change were considered: 50% lower prices, 25% lower prices, 25% higher prices and 50% higher prices. This study was conducted in the months of April, May and June of 2023.

A stated preference survey was used to measure the effect of train ticket price on holiday travel mode choice. Stated preferences indicate what decision people say they will make if introduced to particular *scenarios*, consisting of a set of *options* with different *attributes*. While stated preference approaches are sensitive to hypothetical bias (what respondents say they would do in a hypothetical situation is not necessarily what they would do in reality), they have the advantages of i) allowing the introduction of fictional scenarios that are (not yet) on the market; ii) easier data collection since each participant can be introduced to multiple scenarios; and iii) more precise definition of attribute levels (Sanko 2001).

In the survey, participants were asked to make a travel mode decision between the options of rail and air travel in eight scenarios: one for each of the eight destinations in combination with information on the fixed travel times, fixed air travel costs and one of five, randomly chosen, levels of train costs (-50%, -25%, base level, +25% and 50%). The reason to include just one price level rather than all five was to decrease the response burden and maximize survey participation. Table 1 gives an overview of all destinations and the estimated travel time and travel costs per transport mode.

The survey was shared through individual social media accounts on Instagram, Facebook and LinkedIn where friends and family were invited to fill out the survey (convenience sampling) and asked to further distribute the questionnaire among their contacts (snowballing). In addition, the survey was also distributed through a QR code on paper in the city centers of Nijmegen and Arnhem. Using QR codes for surveys has a positive effect on the response rate (Harrison et al. 2019; Lugtig, Luiten 2021). A total of 218 questionnaires were completed, with 53% female and 47% male respondents. The age distribution was skewed, with 56% of the participants aged between 18 and 24 years and 20% between 25 and 34 years, with much smaller shares for the other age groups 35–44 (7%), 45–54 (6%), 55–64 (7%), and 65+ (3%). Perhaps due to the age distribution, the individual income was low for 61% of the participants, average for 28% and high for 11%. Regarding the highest completed level of education, the largest group (32%) listed secondary school, followed by university (28%), university of applied sciences (27%) and secondary vocational education (12%).

The analysis consisted of predicting the dichotomous variable Preferred Travel Mode with values "train" and "plane" from price index and destination, controlled for a number of socio-demographic variables (gender, age, education and income) by binary logistic regression. The analysis consisted of predicting the dichotomous variable Preferred Travel Mode with values "train" and "plane" from price index and destination, controlled for a number of socio-demographic variables (gender, age, education and income) by binary logistic regression. More, formally, the model could be expressed as

$$\eta_i = \beta_0 + \beta_P price\_index_i + \sum_d \beta_{D(d)} destination_{di} + \beta_G gender_i + \beta_A age_i + \beta_I income_i$$

where the propensity $\eta_i = \text{logit}(\pi_i)$ denotes the logit link (see e.g., Agresti, 1996: p. 73) of π_i = Pr(PreferredTravelMode$_i$ = *plane*).

3. Results

Binomial logistic regression predicting Travel Mode from Destination and Ticket Price produced a model with Nagelkerke pseudo R^2 equal to 47.3%. Specificity (true negative rate) of the model was 85.1% and sensitivity (true positive rate) was 66.9%. Adding the socio-demographics to the model leads to the conclusion that age is irrelevant, while gender, education and income have significant but weak effects, increasing Nagelkerke's pseudo R^2 by only two percent points, arriving at a final measure of 49.6%. See Table 2 for an overview of the model statistics. Figure 1 depicts the estimated probability of travelling by plane in function of ticket price and destination. The results suggest that train ticket prices have considerable effect on holiday travel mode choice: lower train ticket prices result in more train travelers. Results vary between destinations, in that train ticket prices have a weaker impact on holiday travel mode choice for relatively nearby cities such as Berlin and Paris than on modal choice for more distant cities such as Barcelona and Vienna. These findings suggest that travel time may be an important factor in travel mode choice. In fact, the logistic regression model can be drastically simplified by replacing the indicator for destination by a single covariate corresponding to travel time in hours (see Table 1) and omitting the socio-demographic indicators:

$$\eta_i = \beta_0 + \beta_P price\_index_i + \beta_T travel\_time_i.$$

Compared to the model consisting of ticket price and destination, the model consisting solely of ticket price and travel time has only slightly decreased Nagelkerke pseudo R^2 (equal to 42.3%) but does so with a reduction of 7 parameters in the model; see Table 3. The model reduced to its bare essentials reveals that price elasticity is highest for medium travel times, i.e. those between 8 and 13 hours (see Figure 2).

4. Discussion

This pilot study suggests that the impact of (changes in) train ticket prices strongly depend on travel time. For the shortest (i.e., to Berlin, London and Paris) and longest trips (to Barcelona), price changes must be expected to have only limited impact. A potential explanation is that rail travel may have already become the norm for short trips, and that, in contrast, rail travel is as yet poorly developed for very long trips, and is therefore only sensitive to price reductions. The data indicated that medium-range destinations exhibited the greatest responsiveness to price fluctuations in both directions. These results may inform travel policies. Next to general policies such as VAT reductions and subsidies on train tickets to improve the rail sector's competitiveness, a more targeted approach may be effective, in which price reduction efforts are concentrated on medium and long-distance destinations, compensated by slight price increases for the shorter distances if need be. Next to price policy, of course, international railways require major developments in terms of infrastructure, service and market reforms to compete with air travel.

5. Conclusion and outlook

The results point to a significant correlation between price sensitivity and travel time, with price sensitivity being lowest for short and long trips and highest for medium-range trips. However, this exploratory study is subject to limitations, and warrants for future research. The sample was relatively small and consisted for the most part of young people with little to no income, most likely students. Since young people tend to be more aware of and concerned about climate change, the results may have erred on the optimistic side regarding the train's competitiveness. In addition, only train costs were varied, which has resulted in a first-order estimate at best of relative price changes between air and rail. Finally, many large and possibly consequential assumptions and choices were made, such as the use of one-way as opposed to return ticket prices. Nevertheless, the robustness and consistency of the findings warrant more rigorous study of how to most effectively use price policy to improve the competitiveness of international rail travel and accelerate the transition from plane to train.

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Figure 1. Estimated probability of travelling by plane in function of ticket price and destination

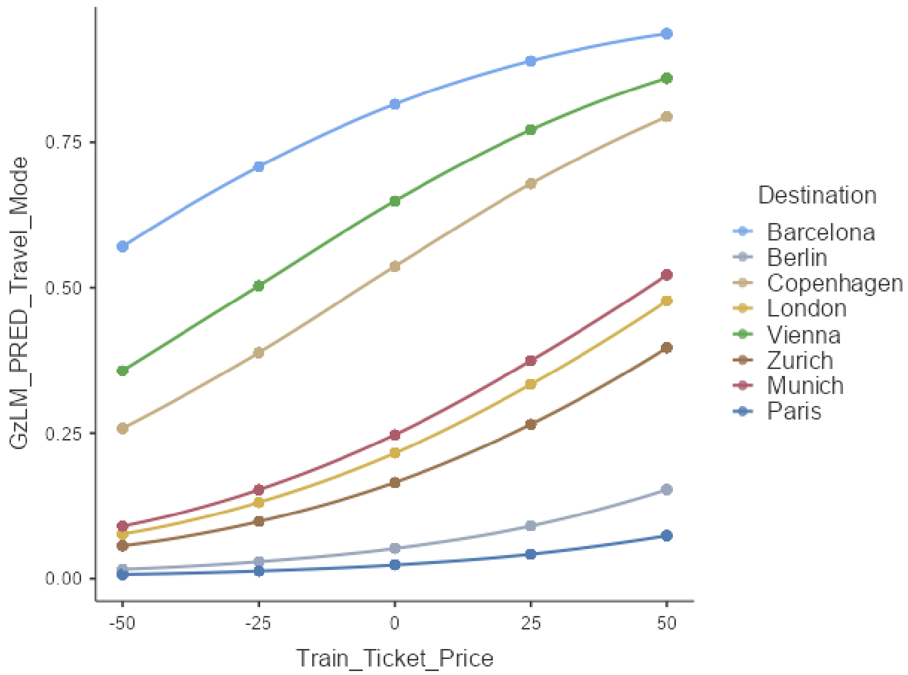

Figure 2. Estimated probability of travelling by plane in function of travel time and ticket price

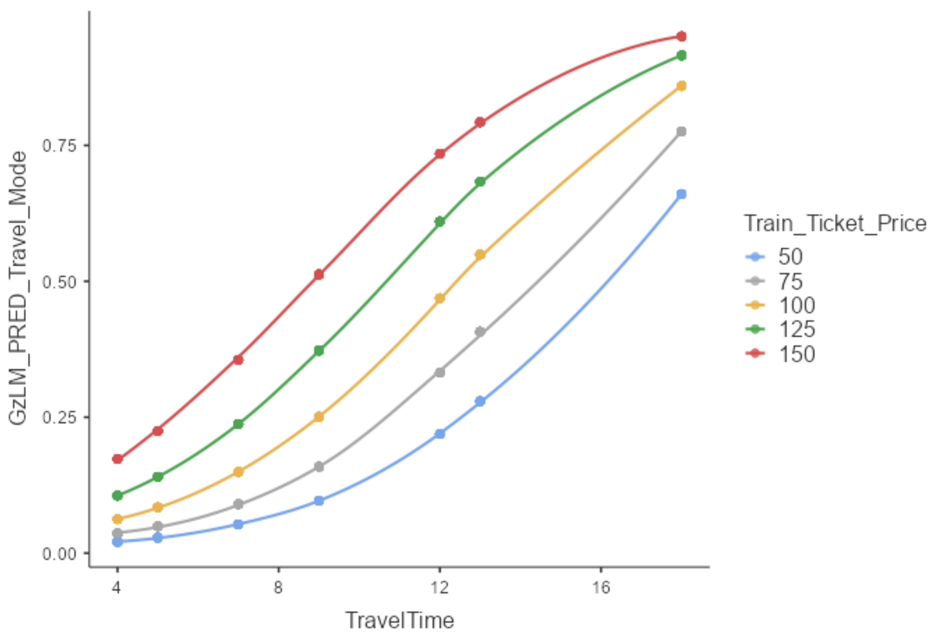

Table 1. Destination, travel time and costs. Note that travel time includes both in-vehicle and out-of-vehicle time

*Train travel costs are variable; the figures in the table are base level costs.

Destination	Travel mode	Travel Time	Travel Costs
Barcelona	Train	18 hours and 2 min	€150*
	Plane	5 hours and 57 min	€235,90
Berlin	Train	7 hours and 8 min	€63*
	Plane	5 hours and 2 min	€148,80
Copenhagen	Train	11 hours and 30 min	€86*
	Plane	4 hours and 47 min	€169,90
London	Train	4 hours and 59 min	€157*
	Plane	5 hours and 7 min	€174,40
Munich	Train	9 hours and 5 min	€108,90*
	Plane	5 hours and 15 min	€192,40
Paris	Train	3 hours and 59 min	€97*
	Plane	5 hours and 22 min	€171
Vienna	Train	12 hours and 59 min	€109*
	Plane	5 hours and 29 min	€194
Zürich	Train	8 hours and 54 min	€79,90*
	Plane	4 hours and 52 min	€189,60

Table 2. Coefficients of the full logistic regression model (Nagelkerke R^2 = 49.6%)

Predictor	Estimate	SE	Z	p
Intercept	1.1964	0.21177	5.650	< .001
Train_Ticket_Price	0.0249	0.00205	12.117	< .001
Destination:				
Barcelona (ref. cat.)				
Berlin	-4.5544	0.34195	-13.319	< .001
Copenhagen	-1.3658	0.23271	-5.869	< .001
London	-2.8513	0.25292	-11.273	< .001
Vienna	-0.8859	0.23704	-3.737	< .001
Zurich	-3.2212	0.26751	-12.042	< .001
Munich	-2.6896	0.24975	-10.769	< .001
Paris	-5.4291	0.44617	-12.168	< .001
Gender:				
Male (ref. cat.)				
Female	0.4246	0.13419	3.164	0.002
Education_level:				
Secundary school (ref. cat)				
Vocational education	0.3364	0.22657	1.485	0.138
Higher professional education	-0.0764	0.19459	-0.393	0.695
University education	-0.1021	0.17321	-0.590	0.555
Other	4.1529	1.28744	3.226	0.001
Individual_Income:				
2000-3999 euro – 0-1999 euro	0.0203	0.16539	0.123	0.902
meer dan 4000 euro – 0-1999 euro	0.8710	0.22421	3.885	< .001

Table 3. Coefficients of the most parsimonious logistic regression model (Nagelkerke R^2 = 42.3%)

Predictor	Estimate	SE	Z	p
Intercept	-3.9988	0.19363	-20.7	< .001
Train_Ticket_Price	0.0229	0.00192	11.9	< .001
TravelTime	0.3228	0.01731	18.6	< .001